Volume 23, Number 7 April 15, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

11395 (CONF-671111-, pp 465-9) STANDARD REFERENCE MATERIALS FOR TRACE ANALYSIS IN THE LIFE SCIENCES. DeVoe, J. R. (National Bureau of Standards, Washington, D. C.).

The National Bureau of Standards recognizes the demand for biological materials certified for a variety of elements at concentrations of 10 to 100 ppM. These standards will be useful as calibrators of an analytical technique. Consequently the standard will be certified to the highest accuracy and precision attainable. So that a good standard can be provided, the material must be homogeneous and have a long shelf life. Preliminary consideration is being given to standards of powdered dry beef liver and blood. (auth)

11396 (RFP-823) GLOVEBOXES LINED WITH TEFLON. Delnay, Robert L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Feb. 7, 1969. Contract AT(29-1)-1106. 7p. Dep. CFSTI.

Gloveboxes fabricated from carbon steel and lined with Teflon fluorocarbon resin produce a corrosion-free enclosure for the analysis of ultra-pure plutonium. The steel glovebox provides the enclosure for handling plutonium and prevents radioactive materials from escaping into the laboratory. The interior surface of the box is a sheet of Teflon cemented to the steel. Glovebox hardware and accessories are fabricated from Teflon or Kel-F resins, or metal coated with a Kel-F dispersion. A stainless steel glovebox was lined with Teflon to verify results of coupon tests. This test glovebox was then used daily to evaluate the practicability of using gloveboxes lined with Teflon for laboratory operations. Some metal surfaces were left exposed so that stainless steel and surfaces lined with Teflon could be compared in the same atmosphere under laboratory usage. (auth)

Chemical Procedures

11397 (AECL-3206) EVALUATION OF TWO AMPEROMETRIC TITRATION METHODS FOR THE DETERMINATION OF PLUTONIUM IN URANIUM FUEL. Venkatasubramanian, V.; Durham, R. W.; Corriveau, V. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sept. 1968. 19p. Dep. CFSTI. CAN $0.50.

An accurate method for determining plutonium in irradiated UO_2 fuel is required for checking the reliability of computer calculations of burnup in nuclear power reactors. Two titration methods were investigated both of which rely on amperometric end-point detection. One is the titration of Pu(VI) with Fe(II) after oxidation of the plutonium with silver peroxide and the other is the titration of Pu(III) with Cr(VI) after reduction of the plutonium with Ti(III). Both methods were found capable of producing precise and accurate results with pure plutonium solutions at the one mg level but the Ti(III) reduction method was more reliable where plutonium had been separated from uranium by anion exchange. This latter method was used to determine the plutonium content of the three zones of a fuel bundle irradiated to about 10 MWd/kg uranium in the Nuclear Power Demonstration Reactor (NPD). (auth)

11398 (CEA-CONF-1111) SURFACE ISOTOPIC ANALYSIS BY LASER SOURCE SINGLE FOCUSING MASS SPECTROMETER. Eloy, Jean-Francois; Contamin, Pierre; Stefani, Rene; Cornu, Ayme (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 10, 1968. 13p. (CONF-680543-1). Dep.

From 16th Annual Conference on Mass Spectrometry and Allied Topics, Pittsburgh, Pa.

It is shown that, with a very simple and cheap apparatus, it becomes possible to obtain rapid superficial isotopic analysis. Operation of the system gives series of data for orientation studies of phenomena involving appreciable modifications in isotopic ratios. Improvements are expected both in precision and detection limit by increasing ion transmittance of the system source-spectrograph and energy of the ions. Subsequent application could involve problems of chemical composition, after study of parameters governing ionic yields. (auth)

11399 (CNEA-219) SPECTROGRAPHIC DETERMINATION OF SILICON IN URANIUM AND AMMONIUM URANYL TRICARBONATE. COMPARISON OF LITHIUM FLUORIDE AND GALLIUM OXIDE CARRIERS. Guido, O. O.; Amaya, C. B. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 17p. (In Spanish). Dep.

The volatility of Si, contained as impurity in uranium oxide U_3O_8 of different origins, was studied by the technique of fractional distillation with carrier. The tests were made with the carriers gallium oxide and alkaline metal fluorides. The spectrographic sensitivity of the Si with gallium oxide and lithium fluoride was determined in a comparative form and the reproducibility was calculated in both cases. The efficiency of the lithium fluoride was proved; a method for the determination of Si in the concentration range from 5 to 200 ppM was developed. There was a relative standard deviation, for one determination, of the order of 15%. The results obtained from this method agree with the results from the spectrophotometric method. (tr-auth)

11400 (GAT-525) SOLVENT EXTRACTION SEPARATIONS WITH BPHA: APPLICATIONS TO THE MICROANALYSIS OF NIOBIUM AND ZIRCONIUM IN URANIUM. Vita, O. A.; Levier, W. A.; Litteral, E. (Goodyear Atomic Corp., Piketon, Ohio). Nov. 1, 1967. Contract AT(33-2)-1. 18p. (CONF-660933-7). Dep. CFSTI.

From 10th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A detailed study of the benzoylphenylhydroxylamine (BPHA)—chloroform—hydrochloric acid solvent extraction system with 52 elements is described with emphasis placed on extraction of the easily hydrolyzed transition metals from strong hydrochloric acid. From this study, a separation procedure for hafnium, niobium, tantalum, titanium, vanadium, and zirconium from uranium was developed, and procedures are given for the microdetermination of niobium and zirconium in uranium. Niobium and zirconium are separated from uranium by extraction into BPHA—chloroform from 10 N HCl. The separated elements are then measured colorimetrically as the niobium-4(2-pyridylazo) resorcinol and zirconium—Arsenazo III complexes. The limit of detection is 1 μg/gU. (auth)

11401 (LA-4047) COMBUSTION MANOMETRIC DETERMINATION OF CARBON IN PLUTONIUM SULFIDE. MacDougall, Carolyn S.; Smith, Maynard E.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). Nov. 11, 1968. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A combustion-manometric method was modified for application to the determination of carbon in the ppM concentration range in plutonium sulfide. The most important modification was the selective trapping of the sulfur oxides, formed during combustion of the sample, to prevent their collection and subsequent contribution to the pressure measured manometrically. The most effective absorbent was chromium trioxide moistened with 18M sulfuric acid. In lieu of plutonium sulfide standards having known carbon contents, samples of plutonium sulfide, previously determined to be homogeneous, were analyzed repeatedly to estimate the reliability of the method. Carbon, in the form of graphite or as a trace impurity in plutonium metal, was added to the sulfides before analysis. The standard deviation calculated from these analyses was about 5 relative % for determining carbon at the 400-ppM level. Interference from the sulfur oxides was not observed with the modified method. (auth)

11402 (Y-1661) DETERMINATION OF TRACE ZINC IN LITHIUM COMPOUNDS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Barringer, R. E.; King, H. G.; Condrey, A. D. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 3, 1969. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Two procedures were developed for determination of zinc in lithium compounds by atomic absorption spectrophotometry: a direct method of aspirating a lithium solution into the burner of an atomic absorption spectrophotometer gave a sensitivity to four micrograms zinc per gram of lithium; and a method in which zinc was extracted into 2-heptanone before aspiration could be extended readily to a sensitivity of 0.1 microgram zinc per gram of lithium. (auth)

11403 FLAME EMISSION SPECTROMETRIC METHOD FOR DETERMINATION OF MOLYBDENUM IN STEELS, FLAME EMISSION SPECTROMETRIC STUDIES OF PHOSPHORUS, AND FLAME EMISSION SPECTROMETRIC DETERMINATION OF SULFUR IN SHIELDED FLAMES. Syty, Augusta. Knoxville, Tenn., Univ. of Tennessee, 1968. 204p.

Thesis.

Optimum conditions for Mo emission from an acetylene-oxygen diffusion flame were studied and a rapid and sensitive method for determination of Mo in steels by flame emission spectrometry was developed. Molybdenum was separated from iron and from many other elements by complexation with α-benzoin oxime in a 5% H_2SO_4 solution followed by extraction into methyl isobutyl ketone. The organic phase was sprayed into the flame and the intensity of the Mo atomic line at 379.8 mμ was measured. Evaluation was completed by the standard addition method. The detection limit (twice the standard deviation of the noise) was 0.5 μg/ml. The analytical usefulness of the green HPO bands and the PO bands in the uv, and the behavior of the P continuum were investigated. The modified burner, reversed air-hydrogen flame, and aerosol spraying assembly were used to study the analytical usefulness of S_2 bands. The best detection limit for S delivered into an air-hydrogen flame as an aqueous aerosol of H_2SO_4 was 5 μg/ml. Emission intensity varied almost directly with the square of the concentration up to 10,000 μg/ml of S. Different S compounds yielded signals of different intensity. Diluting air with Ar enhanced the S_2 band emission. Addition of small amounts of acetylene or oxygen to the air-hydrogen flame quenched the blue S_2 bands. (Diss. Abstr.)(TSS)

11404 SPECTROPHOTOMETRIC DETERMINATION OF TANTALUM. Daniel, Robert Eugene. University, Ala., Univ. of Alabama, 1966. 93p.

Thesis.

The complex of resorcinol with Ta was used for the determination of Ta. The complex was found to be in the mole ratio of one to one. The absorbance was measured in an aqueous solution. was constant for a period of 2 wk or more when exposed to light, had no temperature coefficient over the range 12 to 35°C, and was not affected by most of the elements in the periodic table. Tungsten was the only element found to produce an interference. The interference was eliminated by complexing with EDTA. The absorbance of the Ta–resorcinol complex follows Beer's law up to a tantalum concentration of 0.14 mg/ml in the absence of EDTA and 0.13 mg/ml in the presence of EDTA. The presence of EDTA enhanced the absorbance approximately 15%, thus requiring two calibration curves. The sensitivity of the method was 0.005 mg/ml. The method was applied to samples of tantalites, niobites, microlite, pyrochlore, slags, concentrates, and alloys without the removal of any of the elements present. Most of the solutions were prepared by dissolving a pyrosulfate melt in saturated ammonium oxalate solution, the pH adjusted to less than 1, and the complex formed by heating the Ta–resorcinol solution for 20 min at about 98°C. The pH of the resulting solution was adjusted to 0.50 and the absorbance measured at 434 mμ. The time of analysis was approximately 1.5 to 2 hr. (Diss. Abstr.)

11405 DETERMINATION OF ZIRCONIUM AND HAFNIUM IN NIOBIUM ALLOYS BY APPLICATION OF ION EXCHANGE. Bukhtiarov, V. E. Zavod. Lab., 34: 1297-8(1968). (In Russian).

The method was based on passing a 0.6M HCl–H_2O_2 solution, obtained by dissolution of the alloy, through a cation exchanger. In addition to Zr, Hf, and part of the Nb are absorbed. The latter is eluted by 1% H_2O_2 in HCl. Zirconium is eluted by 0.057N citric acid in HCl and hafnium by 0.33M oxalic acid in 1M HCl. Separation of Zr and Hf from Nb was based on the capability of the latter to form a stable peroxide complex. Zirconium and hafnium were determined complexometrically. Complete separation of Zr and Hf was controlled by the quantity of EDTA consumed on the titration of each element. (tr-auth)

11406 STUDIES ON REAGENTS FOR NIOBIUM AND TANTALUM. II. PROPERTIES OF PYROCATECHOL DERIVATIVES. Ackermann, G.; Koch, S. (Institut fuer Anorganische und Analytische Chemie, Freiburg i. B.). Talanta, 16: 95-9(Jan. 1969). (In German).

The possible improvement in sensitivity and selectivity of analytically useful reagents forming colored chelates with niobium and tantalum is discussed on the basis of theoretical considerations. The formation of such chelates with compounds derived from pyrocatechol was affected by the substituents, and as a result of these studies dibromogallic acid is recommended as a new selective and sensitive reagent for these two metals. (auth)(UK)

11407 ARSENATO–IODOMETRIC DETERMINATION OF CERIUM(IV). Mamedov, I. A.; Nabiev, M. N. Azerb. Khim. Zh., No. 3, 89-91(1968). (In Russian).

A method previously developed for precipitation of cerium(IV) was modified by replacing the acetate environment with a sulfate or nitrate one. Under these conditions cerium can be determined in the presence of a wide range of metals, the arsenates of which are soluble in the environment. (tr-auth)

11408 ABSORPTIOMETRIC DETERMINATION OF BERYLLIUM WITH N-METHYLANABASINE–(α′-AZO-6)-m-AMINOPHENOL(5-AMINO-2-[3-(1-METHYL-2-PIPERIDYL)-2-PYRIDYLAZO]-PHENOL). Dzhiyanbaeva, R. Kh.; Talipov, Sh. T.; Turakhanova, N. T. Nauch. Tr. Tashkent, Gos. Univ., No. 284, 36-41(1967). (In Russian).

N-methylanabasine-(α′-azo-6)-m-aminophenol{5-amino-2-[3-1-methyl-2-piperidyl-2-pyridylazo]-phenol} (I) reacts with Be in acid medium (pH 1.8 to 3) to form a colored 2:1 complex suitable for determination of Be. The absorption maximum of the complex is at 530 nm; Beer's law is obeyed with 0.1 to 0.8 μg of Be per ml. The complex is formed by adding 4 ml of a 0.2% ethanolic solution of I and 10 ml of buffer solution (KCl plus HCl) of pH 2.2 to the test solution, diluting to 26 ml, and measuring the extinction at 530 nm against a blank. There is no interference from the following (tolerable amounts, relative to Be, are given in parentheses) — Mn (400), Cd (200), Ge (100), Mg (90), Ca (50), Cr (19), Al (9), Th (4), EDTA (150), tartrate or oxalate (30), or citrate (25). Fluoride interferes. Interference by Ni (650), U(VI) (480), Co (250), Cu (150), Nb (25), Fe(II) (20), V (12), Ti (10), or Ta (5) is prevented by addition of EDTA. The method was tested on prepared mixtures corresponding in composition to Al and Cu alloys. (Referativnyi Zh.)

11409 NEW COMPLEXOMETRIC DETERMINATION OF ZIRCONIUM. Abdurakhmanov, M.; Talipov, Sh. T.; Dzhiyanbaeva, R. Kh. Tr. Tashkent. Gos. Univ., No. 288, 79-82(1967). (In Russian).

N-methylanabasine-α′-azo-1,5-dihydroxynaphthalene-{[3-(1-methyl-2-piperidyl)-2-pyridylazo]naphthalene-1,5-diol} (I) is used as an indicator for the indirect determination of Zr. This compound reacts with Zr in acid medium to form a green–blue complex with maximum absorption at 620 nm; the maximum absorption of I is at 500 nm. The optimum pH is 1. The test solution (≡3 to 28 mg of Zr in ≈0.5N-H_2SO_4) is diluted to 50 to 60 ml; the pH is adjusted to 1 with aqueous NH_3; a known volume of 0.01M-EDTA and 20 to 40 drops of 0.1% ethanolic I are added; and the solution is titrated with 0.01M-$Bi(NO_3)_3$ to a color change from pink to pale green. The error is <0.35%. There is no interference from Ca, Mn, Mg, Be, Al, Cr(III), Sr, or Hg, nor from the following [tolerated amounts (mg) in parentheses] — tartrate (400), SCN^- (5000), Ti (60), Nb (30), Th (113), Ni (117), Fe (370, with addition of ascorbic acid), or Cu (500, with masking by thiourea). Cadmium, Th, U(VI), Zn, In, Ga, and rare earth metals also form colored complexes with I, but these complexes are destroyed under the conditions for the determination of Zr, and the metals do not interfere. Oxalate, F^-, and PO_4^{3-} interfere. The method is suitable for determining Zr in Mg and Ni alloys. (Referativnyi Zh.)

11410 AMPEROMETRIC METHODS FOR THE DETERMINATION OF SMALL AMOUNTS OF THORIUM. II. AMPEROMETRIC

TITRATION OF THORIUM WITH EDTA AND TWO INDICATOR-ELECTRODES. Khadeev, V. A.; Masalova, L. S. Tr. Tashkent. Gos. Univ., No. 288, 12-17(1967). (In Russian).

Thorium is titrated amperometrically with EDTA in 0.0125 to 0.03N HNO_3 at $\Delta E = 0.2$ V in the presence of MnO_4^- for depolarization of the cathode. In the titration of >0.13 mg of Th in 40 ml, the error is <1%. Manganese, Fe, Cu, and V interfere; Pb, Mo, and Ni are tolerable only in amounts comparable with that of the Th. (Referativnyi Zh.)

11411 SPECTROCHEMICAL DETERMINATION OF TRACE ELEMENTS IN BLOOD SERUM AND URINE. Loiko, E. A. (Inst. of Neurology, Moscow). Lab. Delo, 7: 403-6(1967). (In Russian).

The sample ash is dissolved in 6N HCl, then micro amounts of Al, Be, Fe, Si, Cd, Cu, Mn, Mo, Mg, Ni, Sn, Pb, Ti, and Zn are extracted into $CHCl_3$ after precipitation with 8-hydroxyquinoline and Na diethyldithiocarbamate as appropriate. The extraction is carried out first at pH 4.8 and then at pH 7.0 for complete recovery of the elements. The $CHCl_3$ extract is used for spectrographic analysis in the cavity of a carbon electrode. The spectra are excited in an ac arc (8 amp, 220 V). Strontium and Ge are used as internal standards. The line pairs used are tabulated. The method can also be applied to spinal fluid, tissue, exudates, and transudates. (Anal. Abstr.)

11412 RAPID ANALYSIS OF CERIUM (10^{-1} 10^{-5} PERCENT) IN HIGH PURITY RARE EARTHS BY FLUORESCENCE INTENSITY METHOD. Furukawa, Masamichi; Nakajima, Ryozo (Government Industry Research Inst., Nagoya, Japan). Bunseki Kiki, 6: 573-7(Sept. 1968). (In Japanese).

A fluorescence method was developed for determination of cerium in high-purity rare earths. Measurements of the excited spectrum and the fluorescence spectrum of Ce(III) in dilute HCl, the proportionality of fluorescence intensity to concentration of Ce(III), the effects of variety of acids and their concentrations, the effect of solution temperature, the effects of co-existing rare earths, and the effects of reducing agents were investigated. Results of analyses of the synthesized samples and the practical analyses of rare earths on the market were shown. (NSA of Japan)

11413 DETERMINATION OF HYDROGEN, OXYGEN, AND NITROGEN IN ZIRCONIUM AND ITS ALLOYS. Brhacek, Lubomir; Kalandra, Oldrich (VZKG, Ostrava, Czech.). Chem. Prumysl., 18: 417-21(July-Aug. 1968). (In Czech).

Methods for the determination of hydrogen, oxygen, and nitrogen in zirconium and zirconium alloy C2M were elaborated. Hydrogen was determined by the method of vacuum extraction at 1400°C, the extraction time was 15 min. The analysis was performed chromatographically by the use of argon as a carrier gas, molecular sieve A5 as a separation packing, and catharometer as a detector. Oxygen was determined also by the vacuum extraction method with chromatographic output. In this case the Fe–Sn bath at 1900°C was used and the extraction time was 15 min. For nitrogen determination a wet method, including the sample decomposition by sulfuric acid and potassium sulfate, the distillation of the solution thus produced with NaOH and photometric indication by means of Nessler reagent, was proposed. (auth)

11414 THIN-LAYER CHROMATOGRAPHY OF INORGANIC IONS ON PURE ZIRCONIUM HYPOPHOSPHATE. Koenig, K.-H.; Demel, K. (Univ., Frankfurt am Main). J. Chromatogr., 39: 101-2(Jan. 14, 1969). (In German).

Ascending chromatography on zirconium hypophosphate was studied. Co, Ni, Cu, Zn, Cd, Hg, Sn, Pb, La, Y, Fe, Ga, In, Cs, Ca, Ba, Na, and Sr were identified by use of this chromatogram. (M.C.G.)

11415 N-METHYLANABASINE-(α'-azo-6)-m-AMINOPHENOL (5-AMINO-2-[3-(1-METHYL-2-PIPERIDYL)-2-PYRIDYLAZO] PHENOL) AS REAGENT FOR THE ABSORPTIOMETRIC DETERMINATION OF NIOBIUM. Turakhanova, N. T.; Talipov, Sh. T.; Dzhiyanbaeva, R. Kh.; Shamuratov, Sh. Uzb. Khim. Zh., No. 3, 23-5(1967). (In Russian).

Niobium reacts with 5-amino-2-[3-(1-methyl-2-piperidyl)-2-pyridylazo]phenol (I) to form a colored 1 : 1 complex with maximum absorption at 520 nm; I exhibits maximum absorption at 420 nm. The optimum pH for formation of the complex is 6.25; the molar extinction coefficient of the complex is >12,000. The calibration graph is rectilinear for 0.2 to 1.2 μg of Nb per ml. To the test solution (5 to 30 μg of Nb) was added 4 ml of 0.1% ethanolic I and 6 ml of a citrate buffer solution of pH 6.25, the solution was heated for 3 min. on a boiling-water bath, diluted to 25 ml, and the extinction measured. There was no interference from the following (tolerable amounts, relative to Nb, given in parentheses): Ta and U^{VI} (2), As^{III}, Zr, Ti, Mn and Mo (5), Th (5.5), W (9), Mg and F^- (13), Y (15), Sr (100), and EDTA (200). The error was <±3.5%. (Referativnyi Zh.)

11416 STABLE CARBON ISOTOPE RATIO MEASUREMENTS WITH A GAS DENSITY METER. Wasik, S. P.; Tsang, W. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 761-4(Nov.-Dec. 1968).

A method is presented for measuring $^{13}C/^{12}C$ isotope ratio of organic compounds by burning the material in a stream of normal CO_2, separating the combustion products by gas chromatography, and sequentially measuring the density of the enriched CO_2 peak with a gas density meter. Data are presented for the analysis of enriched ethyl acetate from 15 to 1 percent enrichment. The method is applicable for other stable isotope analysis. (auth)

11417 X-RAY EMISSION ANALYSIS OF HIGH ATOMIC NUMBER ELEMENTS: A NEW EXCITATION SOURCE USING MONO-ENERGIC 477 keV γ-RAYS FROM THE $^{10}B(n,\alpha)^{7m}Li \rightarrow {}^{7}Li$ REACTION. Kowalski, B. R.; Isenhour, T. L. (Univ. of Washington, Seattle). Appl. Spectrosc., 23: 1-4(Jan.-Feb. 1969).

A new excitation source was developed for x-ray emission analysis of high atomic number elements. A mixture of the sample and a small amount of ^{10}B is irradiated in a thermal neutron beam and the resultant x radiation is recorded using a Ge(Li) semiconductor detector and a multichannel analyzer. The ^{10}B undergoes neutron capture ($^{10}B(n,\alpha)^7Li$, $\sigma = 3840b$) producing a single excited state of ^7Li in 92.5% of the captures. Lithium-7m decays with a half-life of about 5×10^{-14} sec emitting a monoenergic 477 keV γ ray. These γ rays are in excellent geometry to the sample and are sufficiently energetic to excite the K x radiation of the highest atomic number elements known. The K x-ray spectra of several elements are presented along with a discussion of sample preparation and apparatus optimization. (auth)

11418 MASS SPECTROMETRY OF SULFUR HEXAFLUORIDE. Sato, Hitoshi; Suzuki, Shohachi; Kagami, Kazuo (Power Reactor Nuclear Fuel Development Corp., Tokyo). Nippon Genshiryoku Gakkaishi, 11: 14-19(1969). (In Japanese).

A mass spectrometric method for measuring the isotope ratio of sulfur was required for evaluating the results of experiments on sulfur hexafluoride in a project related to centrifugal separation. Results obtained in determining the various conditions governing the mass spectrometry of sulfur hexafluoride are described. The SF_5^+ ion was adopted for the sulfur isotope ratio measurements. The ratio was determined from the pattern coefficient of the fragment ions produced upon ionization of sulfur hexafluoride by electron impact. An ATLAS CH4 type mass spectrometer made in Germany was used. Further experiments were undertaken to determine the most favorable conditions for measuring the $^{34}S/^{32}S$ isotope ratio in respect to specimen gas pressure, volume of electron beam, and electron energy. The optimum conditions thus determined were; specimen gas pressure: 2.88×10^2 mmHg, electron beam: 70 ~ 80 μA, electron energy: 30 ~ 40 eV. As an example of the accuracy attainable under the best conditions, a $^{34}S/^{32}S$ value of 4,200 ± 0.008 was obtained. (auth)

11419 PHOTOMETRIC URANYL DETERMINATION BY N-METHYLANABASINE-α-AZO-6-m-AMINOPHENOL. Turakhanova, N. T.; Kamaeva, G.; Dzhiyanbaeva, R. Kh.; Talipov, Sh. T. (Tashkent State Univ.). Uzb. Khim. Zh., No. 4, 67-9(1968). (In Russian).

A photometric method was developed for determining uranyl ions by means of N-methylanabasine-α'-azo-6-m-aminophenol (indexed as 5-amino-2[3-(1-methyl-2-piperidyl)-2-pyridylazo]-phenol). The molar ratios in the true constant K_{true}, equilibrium constant K_r, and instability constant K_{inst}. The method was verified in prepared mixtures of natural ores and concentrates. Tabulated data on uranyl determination in the presence of W, Ta, Mn, Ca, and Mg confirmed the accuracy of the method. (R.V.J.)

11420 PRECIPITATION OF MOLYBDENUM AND THORIUM FROM HOMOGENEOUS SOLUTION. Das, Manoranjan. Boston, Boston Univ. Graduate School, 1968. 90p.

Thesis.

A method was devised for synthesizing benzoinoxime in the presence of Mo(VI) and thus precipitating Mo(VI) from homogeneous solution. Variables affecting the precipitation were studied. The volume of the precipitate was smaller and rate of filtration was more rapid than for the direct precipitation method. Photomicrographs of the precipitate showed a definite improvement over that by the conventional method of Knowles. The MoO_3 concentration in the filtrates was determined and found to be appreciably lower than in the direct method. By using 1 g benzoin and 0.35 g $NH_2OH \cdot HCl$, 12 to 102 mg of MoO_3 could be estimated within an accuracy of 0.2 mg. Reproducibility of the results was excellent. The standard deviation of 29 determinations was found to be 0.083%. The effect of various complexing agents and ions was studied. A method was developed for generating precipitants by photochemical action. Thorium was precipitated from homogeneous solution by the photoreduction of sodium metaperiodate to iodate in perchloric acid medium by means of a 2537 Å low pressure mercury vapor lamp. Thorium was found to be quantitatively precipitated from solution up to a maximum acidity of 1.8 molar $HClO_4$. For weighing, the precipitate was redissolved, precipitated once as thorium hydroxide, and finally as thorium oxalate, which was ignited to thorium dioxide. Quantitative results were obtained in the range of 35 to 180 mg of thorium. Thorium losses in the oxalate filtrate were found to be about 0.13 mg in agreement with results obtained by Kall and Gordon. The amount of thorium left in the iodate filtrate was found to be smaller than that found in the direct addition method. Interference studies were made with ions commonly associated with thorium. The quantum yield of photoreduction of $NaIO_4$ in 0.9N $HClO_4$ medium was determined and found to be about 0.368 ± 0.06. Preliminary work was carried out on a technique in which both the cation and anion of a precipitate were simultaneously produced by photochemical action. (TSS) (Disser. Abstr.)

11421 REACTION OF MOLYBDENUM IONS WITH DITHIOVANILLIC ACID. Rudzit, G. P.; Kauke, A. K.; Yanson, E. Yu. Uch. Zap. Latv. Gos. Univ., 88: 93-7(1967). (In Russian).

Dithiovanillic acid (I) reacts with Mo(V) and Mo(VI) in the molar ratio 2 : 1 to form intensely colored complexes extractable into organic solvents (maximum absorption of the extracts at 410 nm). The extraction is at a maximum for the Mo(V)-I complex at pH 1.5 to 7.5, and for the Mo(VI)-I complex in 0.1M to 1.5M-HCl. The mol. extinction coefficient for these compounds and for pure I (at 380 nm) are 15,000, 40,000, and 2800, respectively. An extraction–absorptiometric method was developed for the determination of Mo with I (Zn salt). To 10 ml of test solution (1 to 30 μg of Mo) HCl was added until the concentration was ≃ M and then 1 ml of 2.5×10^{-3}M-I (Zn salt) in acetone was added, and $CHCl_3$ was used as extracting agent. The extinction of the extract was measured at 425 nm against a blank. There was no interference from W(VI), Cr(III), Ti(IV), Mn(II), Fe(II), Zn, U(VI), Ga or Tl(I). Moderate amounts of Cu(II) are masked with thiourea, and Fe(III) is masked with EDTA or reduced to Fe(II) with ascorbic acid. Nickel, Co, Bi, V(V), Sb, Sn and Pb interfere. (Referativnyi Zh.)

11422 CALCULATION FROM MASS SPECTROMETRIC MEASUREMENTS OF THE ABUNDANCES OF OXYGEN ISOTOPES IN CARBON DIOXIDE. Turnbull, A. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., D (London), 1: 1793-9(Dec. 1968).

When the isotopic abundances of oxygen in carbon dioxide are to be determined from the mass spectrum of the latter, it seems desirable at first sight to base calculations on the three largest peaks in the spectrum. In certain cases, however, this procedure produces inaccurate answers. Taking a range of carbon dioxides whose oxygen isotopic abundances varies widely enough to cover all realistic cases, examination of the contributions of the oxygen isotopes to the six CO_2^+ peaks in the mass spectrum indicated how to choose three peaks on which to base abundance calculations which will avoid these inaccuracies. "Best expressions" for oxygen isotopic abundances are tabulated against CO_2^+ peak patterns. (auth) (UK)

11423 MICRO-SEPARATION AND IDENTIFICATION OF FORTY-SIX CATIONS BY ALL GLASS NICHROME WIRE RING CHAMBER. Hashmi, M. H.; Shahid, Maqbool Ahmad; Chugtai, N. A.; Rana, Mushtaq Ahmad (Pakistan Council of Scientific and Industrial Research, Lahore). Mikrochim. Acta, No. 6, 1143-53 (1968).

An all glass nichrome wire ring chamber for the separation and identification of 46 metal ions from a single drop of test solution is described. Before analysis, the cations are separated into 6 groups by liquid-liquid extraction. The total analysis takes about 1 hour and the method holds an excellent promise for the identification of airborne particulates and trace elements from blood, bone, tissues, food materials, etc. (auth)

11424 . FLUOROMETRIC METHOD FOR DETERMINING TRACE QUANTITIES OF FLUORIDE. Guyon, John C.; Jones, Berwyn E.; Britton, David A. (Univ. of Missouri, Columbia). Mikrochim. Acta, No. 6, 1180-4(1968).

A very selective method has been developed for the determination of microgram quantities of fluoride based on the fluorescence quenching by fluoride of the zirconium-flavonol chelate. The fluorescence intensity is read at 460 nm. The reduction in fluorescence intensity caused by the fluoride is a measure of the fluoride concentration present. (auth)

11425 A STUDY OF THE INFLUENCE OF BUFFERS ON SENSITIVITY IN THE SPECTROCHEMICAL ANALYSIS OF GLASS-MAKING SANDS BY THE CATHODE EXCITATION METHOD. Hanna, Z. G.; Abdellha, Mahmoud H. (National Research Centre, Cairo). Mikrochim. Acta, No. 6, 1244-53(1968).

The limits of identification are given for the spectrochemical determination by the cathode excitation technique, of the volatile, medium, and heavy volatile elements in glass-making sands. There is a relationship between the lowest limit of detection of the matrix elements and the different buffers added at various concentrations. This is because variations in the intensities of the lines of the constituent elements on the addition of buffers appear to be closely connected not only with the initial ionization potential of the constituent elements of the matrix, but to a greater extent with the chemical nature of the newly formed species within the crater and their rate of volatility at a given temperature when the arc is struck. (auth)

11426 A STUDY OF THE INFLUENCE OF BUFFERS ON SENSITIVITY IN THE SPECTROCHEMICAL ANALYSIS OF GLASS-MAKING SANDS BY THE ANODE EXCITATION METHOD. Hanna, Z. G.; Abdellha, Mahmoud H. (National Research Centre, Cairo). Mikrochim. Acta, No. 6, 1254-8(1968).

A spectrochemical study dealing with the determination of some 20 trace elements in glass-making sands is reported. The effects of change of buffers, and hence of the matrix composition, on the line intensity are discussed. The detection limits for the elements determined are provided. The cathode and anode excitation methods were compared. (auth)

11427 EFFECT OF ROSE BENGAL PURITY ON THE LIVER FUNCTION TEST. I. DETERMINATION OF RADIOCHEMICAL PURITY AND COMPARISON OF VARIOUS COMMERCIAL PREPARATIONS. Raban, P.; Gregora, V.; Brousil, J.; Jirounek, P. (Charles Univ., Prague). Nucl.-Med., 7: 257-65(Oct. 31, 1968).

Chromatographic separation of several commercial Rose Bengal preparations revealed their very variable purity. The R_F and absorption maxima values indicate that the Rose Bengal preparations differ both in content and in character of colored impurities. Most of them are radioactive so that influence on the liver chromoexcretion test is highly probable. The validity of the presumption that they are less iodinated tetrachlorofluorescein derivatives was investigated by comparison with compounds prepared by iodination of pure tetrachlorofluorescein. However, it was demonstrated that these compounds did not appear in the Rose Bengal preparations studied and that the colored radiochemical impurities were probably fluorescein derivatives differing by the substitution in the phthalanhydride moiety. (auth)

Isotopic Procedures

Refer also to abstracts 11414 and 11782.

11428 (CONF-671111-, pp 395-412) ISOTOPE-DILUTION METHODS USING COATED CHARCOAL. Zalusky, Ralph; Herbert, Victor (Mount Sinai Hospital, New York. Mount Sinai School of Medicine, New York).

Charcoal coated with molecules of known size and configuration behaves as a "molecular sieve," allowing adsorption of smaller molecules but rejecting larger ones. This method affords "instant dialysis" for separation of unbound vitamins, minerals, and hormones from their complexed forms. Procedures for measuring vitamin B_{12}, plasma iron, and pteroylglutamic acid were developed by combining coated-charcoal separation with isotope-dilution principles. Requirements for these assays are that the agent to be measured must be adsorbable by charcoal in its free form, the agent must be available in an isotopic form, and a specific binder for the agent must exist whose molecular weight and configuration is sufficiently different from that of the agent so that only the free agent and not the agent attached to its binder will be adsorbed by the coated charcoal. (auth)

11429 DETERMINATION OF COSMIC-RAY-PRODUCED TITANIUM AND VANADIUM IN IRON METEORITES. Imamura, Mineo; Shima, Masako (Tokyo Univ.). Shitsuryo Bunseki, 16: 291-302(Dec. 1968). (In Japanese).

The concentration of cosmic-ray-produced stable nuclides of Ti and V in iron meteorites, especially in the Grant meteorite, were determined by a surface ionization solid source mass spectrometer using an electron multiplier. A triple filament technique was applied for both elements. Repeated experiments using 0.1 to 1 μg quantity of reagent Ti and V indicated a satisfactorily high reproducibility throughout the course of this work. The results with the reagent Ti and V were in a good agreement with the determinations by other methods. Using about 1 g of the Fe meteorites specimen, the extractions of Ti and V were performed simultaneously in a systematic wet chemical separation scheme with K, Ca, Cr, and Mn. For determination of the absolute contents of cosmogenic nuclides, isotopic dilution analysis was carried out using enriched ^{46}Ti for Ti and reagent V for V as the spikes. Determination of these nuclides were possible with sufficiently low contamination of natural elements at the levels of 0.1 ppM for Ti and 0.01 ppM for V. The enrichment in ^{49}Ti was observed most prominently in the mass spectrum of Ti samples separated from the iron meteorites. At the same time the other products, ^{47}Ti and ^{48}Ti were also determined with a high reproducibility. ^{50}Ti was also measurable though the error, ±30%, was still high. A set of data at A = 50, which includes new data for ^{50}Ti and ^{50}V, and previous data on ^{50}Cr and ^{50}V were completed. The distribution of these three isobars provides useful measure in the spallation systematics in meteorites. Two parameters, R and S, in the semiempirical equation of spallation cross section, $\ln\sigma(Z) = -R(Z-SA)^2 + K$, were calculated to be 1.5 ± 0.2 and 0.469 ± 0.001, respectively. The radiation age of Aroos was estimated applying widely ranged pairs of both radioactive and stable nuclides, which were now all available. Each age derived from different isobaric pairs agreed well and this may suggest the negligible effect of space erosion or similar mechanisms such as many small collisions in space. In Grant, the depth effect was found to be effectively negligible for ^{49}Ti and ^{50}V in contrast to lighter nuclides such as Ne and K. No irregularity in a curve of spallation yield vs. ΔA was not observed in the mass range from 46 to 49. The experimental procedure is described in detail. (NSA of Japan)

11430 DETERMINATION OF COSMIC-RAY-PRODUCED POTASSIUM AND CALCIUM IN IRON METEORITES. Shima, Masako; Imamura, Mineo (Tokyo Univ.). Shitsuryo Bunseki, 16: 277-90(Dec. 1968). (In Japanese).

A long-lived radionuclide ^{40}K and stable nuclides of Ca produced by cosmic rays in iron meteorites were determined by mass spectrometry using a surface ionization technique with an electron multiplier. These nuclides were extracted simultaneously in a systematic wet chemical separation scheme with other stable nuclides of Ti, V, Cr, and ^{53}Mn. For the determination of absolute contents of the products, the dilution method was applied using ^{39}K and ^{42}Ca. In such samples, the enrichment of ^{42}Ca, ^{43}Ca, ^{44}Ca, and ^{46}Ca due to cosmic-ray products was observed at 70, 200, 20, and 200% respectively. Most of the ^{40}K extracted from iron meteorites was found to be cosmic-ray products even at a higher contamination level. For isotope fractionation and isotope discrimination, long-lived ^{40}K seems not to be affected seriously because of the very high ratio of cosmic-ray product to natural ^{40}K. At lowest contamination, cosmic-ray-produced ^{41}K should be detected at about 5% enrichment in mass 41 peak, however, with no means to correct the isotope fractionation and discrimination of K, the ^{41}K could not be determined. Calcium-40 and ^{48}Ca are produced in negligible amounts by cosmic-ray irradiation. The isotope fractionation and discrimination in mass spectrometry were corrected by normalizing ^{40}Ca and ^{48}Ca peaks in samples to their reference values, which were selected from data on reagent calcium. In order to eliminate disturbances caused by hydrocarbons at mass peaks of 42 and 43, the cavity of the ion source in mass spectrometer and the filament had to be baked before the measurement in each run. A dependency on depth in the Grant meteorite was found to be about 20%; it smoothly decreased from the surface to the center for both ^{40}K and Ca. The number of samples was not sufficient for a determination of preatomospheric size of the meteorite. A fine structure in a cumulative spallation yield curve was examined in the isotopic ratios of cosmic-ray-produced Ca analyzed in a highly enriched sample. The yields of ^{42}Ca and ^{44}Ca were 10 ± 5% higher than an expected yield of ^{43}Ca. Experimental procedures, especially the chemical procedure and the mass spectrometry of very small amounts of these elements are described in detail. (NSA of Japan)

Radiometric Procedures

Refer also to abstracts 11830, 11943, 11945, 11951, and 11954.

11431 (COO-119-237, pp 158-62) EHPA-SCINTILLATOR METHOD: ANALYSIS OF BONE SAMPLES FOR ^{239}Pu. Atherton, David R. (Utah Univ., Salt Lake City. Radiobiology Div.).

Bone samples are ashed and put into nitric acid solution. The plutonium is reduced by addition of SO_2 and extracted using bis(2-ethylhexyl) phosphorate. A scintillation counter is used to determine the amount of plutonium present relative to a standard solution. Samples containing about 15 pCi could be evaluated to about ±5% if 100 minute counting times were used. (M.C.G.)

11432 JOINT DETERMINATION OF ^{230}Th AND ^{232}Th. Meyer, H. G.; Born, H.-J.; Staerk, H.; Turkowsky, C. (Technische Hochschule, Munich). Radiochim. Acta, 10: 128-33(Dec. 1968). (In German).

An analytical method for the determination of ^{232}Th at concentrations of ≥0.1 ppM and of ^{230}Th at concentrations of ≥0.1 ppB in one sample is described. After addition of ^{234}Th tracer the thorium is adsorbed carrier-free on a cation exchange resin, separated from interfering elements, eluted with EDTA-solution and precipitated as $Th(OH)_4$ together with $TiO(OH)_2$. The ^{230}Th content is determined by measuring the α-activity, the chemical yield by measuring the β- or γ-activity of the tracer. The ^{232}Th is determined by a neutron irradiation and measuring the γ-activity of ^{233}Pa. (auth)

11433 AN INVESTIGATION OF THE FEASIBILITY OF MAKING RADIOMETRIC TITRATIONS OF PRECIPITATION REACTIONS. Hammerstrom, Harold Elmore. Stockton, Calif., Univ. of the Pacific, 1968. 136p.

Thesis.

Investigations were carried out to determine the feasibility of performing radiometric titrations using low activity radioisotopes and inexpensive equipment; to develop a workable procedure for performing radiometric titrations in the classroom; and to assemble the basic radioactive concepts needed so the content could be used in a chemistry course of study. Physical conditions and setup necessary for performing radiometric titrations in a classroom were investigated. Using this setup, the feasibility of radiometric titrations was determined for precipitation reactions using, as the indicator, one or more of the following radioisotopes: ^{45}Ca, ^{125}I, ^{131}I, ^{110}Ag, ^{36}Cl, ^{185}W, ^{204}Tl, and ^{35}S. A field study was conducted in which a total of 62 students performed a radiometric titration. Their average results agreed almost exactly with the accepted value. Their average deviations were of the same order of magnitude as the accuracy reported in many studies using radioisotopes of high activity. The effects of complexation and pH dependence was also studied for some of the systems. The affect on the titration curve shape agrees well with the theoretical predictions. In addition to the delineation of new systems for radiometric titrations, this study provided a method of teaching radioactive concepts in a manner that allows safe student participation. Student participation not only allows the teaching of radioactive concepts, the techniques of radioactive solution handling and disposals, and an analytical method, but also allows ready observation of the factors affecting solubility. (Diss. Abstr.)(TSS)

11434 METHOD FOR DETERMINATION OF PLUTONIUM IN BLOOD BY ANION EXCHANGE. Akaishi, Jun (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 6: 12-19(Jan. 1969).

The anion exchange behavior of Pu(IV) and Pu(VI) was studied in solutions of both nitric acid and an ethanol-nitric acid mixture, and a method of determining plutonium content in blood was developed. About 10 ml of blood were wet-incinerated with concentrated nitric acid and evaporated to dryness. The residue was dissolved in 8 ml of $8\underline{N}$ nitric acid, and 12 ml of ethanol was added. The solution was passed through a resin column of Dowex 2, X8 (9 mm dia, 3.0 cm long). After washing the column with ethanol-nitric acid mixed solution, plutonium was eluted with 10 ml of $1\underline{N}$ nitric acid containing sulfur dioxide. The eluate was transferred to a cell for electrodeposition, which was carried out with 500 mA/cm^2 for 3 hr using a stainless steel disk as cathode. The plutonium yield from the ion exchange was 85 to 91%, and the electrodeposition quantitative. The blank activity from the reagents, resin and disk was 10^{-14} Ci. With this method a 10-hr count with a silicone semiconductor spectrometer, will permit determination of $5 \times 10^{-14} \sim 10^{-13}$ Ci of plutonium in 10 ml of blood. (auth)

11435 ESTIMATION OF RADIOACTIVE ACID MUCOPOLYSACCHARIDES. Paunio, Keijo U.; Maekinen, Kauko K. (Univ. of Turku, Finland). J. Chromatogr., 39: 96-8(Jan. 14, 1969).

A method for determining the radioactivity of sulfated mucopolysaccharides directly from cellulose acetate sheets following electrophoresis, without time-consuming preparation of samples for radioactivity measurements, is described. After electrophoretic fractionation of the acid mucopolysaccharides, acetate membranes were stained with Alcian Blue. Color intensity of mucopolysaccharide fractions and distribution of radioactivity were determined. Results indicated that the fractions detected with Alcian Blue coincided with radioactivity in the sheet. (J.G.B.)

11436 RAPID METHOD FOR THE RADIOCHEMICAL DETERMINATION OF ^{95}Zr–^{95}Nb IN SEA WATER. Ikeda, Nagao; Kimura, Kan; Izawa, Koichi; Yasui, Toshiko (Tokyo Kyoiku Univ.). Radioisotopes (Tokyo), 18: 8-11(Jan. 1969).

A simple and rapid method is proposed for the determination of ^{95}Zr−^{95}Nb in seawater. The method is based on the coprecipitation of ^{95}Zr−^{95}Nb on lanthanum hydroxide followed by the extraction with 5% tri-n-butyl phosphate in toluene from 10N hydrochloric acid solution. A high decontamination from other fission products was attained and the yield of ^{95}Zr−^{95}Nb was larger than 99%. (auth)

11437 ATOMIC NUMBER EFFECTS IN ELECTRON PROBE MICROANALYSIS. Sawatani, Tadashi; Murota, Shoji (Tokyo Research Inst. Yawata Iron and Steel Co., Ltd., Kawasaki, Japan). Nippon Kinzoku Gakkaishi, 32: 1167-71(1968). (In Japanese).

The atomic number effect in quantitative electron microprobe analysis is discussed. The computer method of Archard and Mulvey was modified using Webster's law in order to calculate the energy loss suffered by the electron passing through the solid target, Green and Cosslett's expression for the relation between electron energy and ionization cross sections, and Cosslett's expression for the diffusion range. A comparison between calculated results and experimentally determined values was made for a Au−Cu alloy, and after good agreement was confirmed, the correction factors of atomic number effect were calculated for several iron-base binary alloys. Quantitative electron probe microanalysis was performed on Fe−Al, Fe−Si, Fe−Mo, and Fe−W alloys and compared with the computed values. (auth)

11438 METHOD OF ISOTOPIC RATIO DETERMINATION OF URANIUM BY Ge(Li) DETECTOR. Chiba, Ren; Ebisawa, Katsuyuki (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 6: 45-6(Jan. 1969).

The isotopic ratio between ^{235}U and ^{238}U was determined using a 9 cc Ge(Li) coaxial type detector and a charge-sensitive preamplifier with field effect transistor. A prominent peak at 185 keV corresponds to γ rays from ^{231}Th changing from 3rd excited state ($^5\!/_2$) to ground state, followed by α decay of ^{235}U. The abundance of ^{235}U can be calculated from the intensity of the 185 keV γ rays relative to that of the standard sample obtained under identical and reproducible experimental conditions. The accuracy of the method is limited mainly by the statistical uncertainty of the 185 keV, the errors in the isotopic ratio obtained are within 3×10^{-3} with 24 hr measurement and for slightly enriched U. (P.C.H.)

11439 DETERMINATION OF ^{137}Cs IN SOIL. Bauman, Alice (Inst. for Medical Research, Zagreb). pp 335-8 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The method is based on the final precipitation of ^{137}Cs as cesium triphenylcyanoborate. Sodium triphenylcyanoborate has not been used before as a reagent for determination of radioactive cesium, at least not in the samples of biosphere. Conditions of optimal leaching of ^{137}Cs from various types of soil were found. A 256-channel analyzer was used for sample counting. Conditions of optimal precipitation of cesium were determined. (auth)

11440 RADIOACTIVITY ASSAY OF ^{35}S IN LABELLED ORGANIC COMPOUNDS. Barakat, M. F.; Zahran, A. H. (Atomic Energy Establishment, Cairo). Int. J. Appl. Radiat. Isotop., 20: 109-14(Feb. 1969).

A simple, accurate, and rapid technique is described for the determination of ^{35}S in labelled organic compounds using the gas-flow monitoring counter. The organic material is ignited and the oxidation products are swept by means of carrier gas argon, and concurrently with butane−butylene mixture are passed through the gas-flow monitoring counter for registration of the passing activity. Analysis of a sample requires 25 to 30 minutes and samples with specific activities as low as fractions of a nCi/mg can be readily measured. Other techniques for the assay of ^{35}S are also reviewed and compared with this gas counting technique. (auth) (UK)

11441 A SIMPLIFIED METHOD FOR DETERMINATION OF ^{59}Fe AND ^{55}Fe IN PLASMA USING LIQUID SCINTILLATION COUNTING. Miller, M.; Kereiakes, J. G.; Friedman, B. I. (Univ. of Cincinnati). Int. J. Appl. Radiat. Isotop., 20: 133-5(Feb. 1969).

In order to compare the clearance of blood plasma-bound and free radioactive iron injected into the plasma space, a simple practical method for simultaneous counting of ^{59}Fe and ^{55}Fe was developed. In the past, methods for counting ^{55}Fe which emits a 0.0059 MeV x ray, have required digestion and separation of the iron by electroplating, wet digestion, and precipitation of ^{55}Fe as ferric hydroxide, or emulsification in a thixotropic gel. With the method described the plasma is pipetted directly into the counting bottle without prior manipulation. Some clearance results are described and discussed. (auth) (UK)

11442 PREPARATION OF TISSUES FOR LIQUID SCINTILLATION RADIOACTIVITY COUNTING. Lindsay, Paul A.; Kurnick, N. B. (Veterans Administration Hospital, Long Beach, Calif. Univ. of California, Irvine). Int. J. Appl. Radiat. Isotop., 20: 97-102(Feb. 1969).

The method described produces samples with a low degree of quenching and is especially suitable when radionuclides of very low energy of emission are used. Small amounts of Triton X-100 and NCS (Nuclear Chicago Corp.) are used to dissolve completely 20 mg of tissue in a scintillation mixture, followed by optional bleaching of the solution by exposure to light. (auth) (UK)

Activation Procedures

Refer also to abstracts 11837, 11943, 11963–11965, 12307, and 13178.

11443 (BNWL-481-2) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1966 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 2. RADIOLOGICAL SCIENCES. Pearce, D. W.; Compton, M. R. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 203p. Dep. CFSTI.

Three sections are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual sections see: 11444, 11529, and 11752.

11444 (BNWL-481-2, pp 1-126) RADIOLOGICAL CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

AGE—effects on iron-55 content in worldwide populations during 1966
ALASKA—cesium-137 content in Eskimos in, during summer 1966
ANIMALS—lead-210 content in tissues of, in Alaska
ATMOSPHERE—radioisotope content in, in ratio with content in water basins in vicinity of Hanford reactors
  —bismuth-207 content in Hanford area, Sept. to Oct. 1966 from nuclear tests
  —analysis for hydrogen chloride gas, spectrophotometric and radiometric methods for
  —sampling of, development and construction of portable boom-type equipment for
ATMOSPHERIC PRECIPITATION—analysis for trace element washout by neutron activation and multidimensional γ spectrometry
BIOLOGICAL MATERIALS—radioisotope distribution in Olympic National Park environment
  —analysis for trace elements by neutron activation and multidimensional γ spectrometry
  —analysis for selenium by neutron activation and lithium-drifted germanium γ spectrometry
CALCIUM-49—effects on determination of total-body calcium in man by neutron activation
CEREALS—flour, radioisotope content in commercial, artificial and natural
CHEMICALS AND REAGENTS—contamination of, effects on analysis of seawater for trace elements
  —analysis for trace elements by neutron activation and γ spectrometry
CHLORINE-38—effects on determination of total-body calcium in man by neutron activation
COLUMBIA RIVER—radioisotope content in, during Hanford Reactor shutdown, studies on chemical and physical forms of
  —radioisotope content in bottom silts in, effects of shutdown of Hanford reactors on
  —radioisotope transport in, effects of shutdown of Hanford reactors on
  —zinc-65 uptake and release by bed of, effects of shutdown of Hanford reactors on
COSMIC RADIATION—effects on radioisotopes production in rainwater
CRUSTACEA—Euphausia sp, analysis for trace elements by neutron activation and γ spectrometry
DIET—effects on iron-55 content in worldwide populations during 1966
ENVIRONMENT—radioisotope content and distribution in Olympic National Park
GAMMA RADIATION—dosimetry in man exposed to high-energy photons, instruments for
GAMMA SPECTROMETERS—evaluation of multidimensional, for whole-body counting

—development of large thallium-activated sodium iodide, for determining radioisotopes in meteorites
—design of thallium-activated sodium iodide scintillation, reduction of background and γ scattering and increasing of peak efficiency in
—evaluation of multichannel, for whole-body counting
KRYPTON-85—properties for use as tracer in atmosphere
MAN—analysis for sodium-24, evaluation of multidimensional γ spectrometry for whole-body
—radiation dosimetry of, exposed to high-energy photons, instruments for
—radioinduced activity in, by low-level neutrons, feasibility of measuring
—analysis for total-body calcium by neutron activation
MEATS—analysis for lipids by fast neutron activation, in vitro and in vivo
METEORITES—analysis for radioisotopes, development of large thallium-activated sodium iodide γ spectrometer for
MOLLUSCA—Loligo sp., analysis for trace elements by neutron activation and γ spectrometry
NEODYMIUM-144—proton reactions with, production of promethium-143 and -144 from
NEUTRONS—effects on induction of radioactivity in man, feasibility of measuring
—effects of cosmic, on background of thallium-activated sodium iodide γ spectrometers
NEUTRONS, FAST—dosimetry in man exposed to high-energy photons, instruments for
NEUTRONS, THERMAL—dosimetry in man exposed to high-energy photons, instruments for
NUCLEAR EXPLOSIONS, ATMOSPHERIC—effects on bismuth-207 content in atmosphere in Hanford area Sept. to Oct. 1966
— fallout from, seasonal variations in content and distribution of
OSTEICHTHYES—analysis for trace elements by neutron activation and γ spectrometry
PACIFIC OCEAN—analysis of surface water of, for radioisotopes by ion exchange and γ spectrometry
PARTICLES—diffusion in atmosphere, krypton-85 tracer studies on
PLASTICS—analysis for trace elements by neutron activation and γ spectrometry
— contamination of, effects on analysis of seawater for trace elements
POPULATIONS—iron-55 content in worldwide, during 1966, effects of age, diet, and sex on
POTASSIUM-40—determination in hardware, reflective coatings, and light pipe materials of thallium-activated sodium iodide crystal assemblies of γ spectrometers
RADIOISOTOPES—determination in man, evaluation of multidimensional γ spectrometry for whole-body
RICHLAND AREA (WASH.)—bismuth-207 content in atmosphere in, Sept. to Oct. 1966 from nuclear tests
SEAWATER—analysis for trace elements, role of contamination in container materials, reagents, and solvents in
SEX— effects on iron-55 content in worldwide populations during 1966
SILTS—analysis of marine, for trace elements by neutron activation and γ spectrometry
—radioisotope content in bottom, in Columbia River, effects of shutdown of Hanford reactors on
SODIUM-24—effects on determination of total-body calcium in man by neutron activation
SOLVENTS—contamination of, effects on analysis of seawater for trace elements
— analysis for trace elements by neutron activation and γ spectrometry
SULFUR-37—effects on determination of total-body calcium in man by neutron activation
THORIUM-232—determination in hardware, reflective coatings, and light pipe materials of thallium-activated sodium iodide crystal assemblies of γ spectrometers
TROPOSPHERE—radioisotope content and distribution in lower, from nuclear tests, seasonal variations in
URANIUM-238—determination in hardware, reflective coatings, and light pipe materials of thallium-activated sodium iodide crystal assemblies of γ spectrometers
URINE—radioisotope excretion in, by Alaskan Eskimos, effects of diet on
VESSELS—contamination of, effects on analysis of seawater for trace elements
—analysis for trace elements by neutron activation and γ spectrometry
WHOLE-BODY COUNTERS—development of six crystal rotational (B.G.D.)

11445 (CEA-CONF-1057) QUANTITATIVE DETERMINATION OF IMPURITIES IN NUCLEAR GRAPHITE BY ACTIVATION ANALYSIS. May, S.; Pinte, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 13, 1968. 17p. (In French). (CONF-681003-9). Dep.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

A neutron activation method was developed for the systematic analysis of one nuclear graphite sample for Ag, Si, Hg, Sb, Cu, Fe, Ga, Co, Cd, Zn, In, Zr, Cr, Sc, Ba, Ca, Na, K, Rb, and Cs. Methods used for the determination of all the rare earths, S, and P, as well as elements that can be determined without chemical separation, Cl, Mn, and V, are also presented. (J.G.B.)

11446 (CONF-671111-, pp 439-54) BASIC CONCEPTS OF ACTIVATION ANALYSIS. Lyon, W. S. (Oak Ridge National Lab., Tenn.).

Activation analysis is a technique by which a stable isotope of an element is made radioactive through reaction with a nuclear particle such as a neutron. Measurement of the induced radioactivity permits determination of stable isotope originally present. Modern instrumental techniques made many activation analyses wholly nondestructive, although interferences both from contaminating elements and from competing reactions sometimes complicate the process. A reactor neutron activation is the most used technique, but 14-MeV neutron generators as well as charged-particle accelerators are becoming increasingly important as tools in activation analysis. (auth)

11447 (CONF-671111-, pp 455-64) ACTIVATION ANALYSIS: TECHNIQUES AND METHODOLOGY. Leddicotte, G. W. (Missouri Univ., Columbia).

Information about the techniques followed in completing an activation analysis of a sample material for its trace-element content is discussed. (auth)

11448 (CONF-671111-, pp 471-90) ANALYSIS OF BIOLOGIC TISSUE WITHOUT CHEMICAL SEPARATION. Cooper, Raymond D. (Army Natick Labs., Mass. Massachusetts Inst. of Tech., Cambridge); Linekin, David M. (Massachusetts General Hospital, Boston); Brownell, Gordon L. (Massachusetts General Hospital, Boston. Massachusetts Inst. of Tech., Cambridge).

Although activation analysis has important advantages, such as very high sensitivity and the ability to measure several elements simultaneously, its usefulness was somewhat limited by interference problems due to the poor resolution of γ detectors and very high yields of certain isotopes that cover up many of the other elements present. The interference problem caused by poor resolution was eliminated by the construction of a spectrometer consisting of a 35-cm^3 Ge(Li) detector surrounded by a large plastic scintillator for Compton suppression. A resolution of about 6 keV and a reduction of the Compton background to one-half of its normal value was obtained, resulting in a photopeak-to-Compton ratio of 7 to 1 for ^{137}Cs γ rays. The effect of the second major interference due to one or more high-yield isotopes was reduced by a variety of techniques, including short irradiation times, an initial and a later measurement to allow decay of the interfering isotopes, and bremsstrahlung activation to produce different activities. The spectrometer and these techniques were applied to the measurement of trace elements in blood samples with the objective of studying the correlation between element concentration and disease. It was found that approximately 20 different elements can be measured in this way without the necessity for any chemical separations. (auth)

11449 (CONF-671111-, pp 523-31) ACTIVATION ANALYSIS IN FORENSIC SCIENCE. Lenihan, J. M. A. (National Health Service, Glasgow (Scotland). Western Regional Hospital Board).

Activation analysis has important potentialities in the forensic realm. The remarkable sensitivity of the technique has already been exploited in developing methods of identification applicable to paint, glass, gunshot residues, narcotic drugs, liquor, and hair. There is a need for more abundant basic data on normal concentrations of trace elements in these materials as well as on variations attributable to time, place, and (in the human subject) individual characteristics. Activation analysis is capable of becoming a significant aid in the fight against crime, but its acceptance by the courts depends on proper appreciation of nontechnical factors relating to the collection, processing, and submission of evidence. (auth)

11450 (CONF-671111-, pp 533-43) AVAILABILITY AND PRESENT STATUS OF ACTIVATION ANALYSIS. Guinn, Vincent P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The study of trace elements is an important aspect of current research in the fields of biology and medicine. Because of its extreme sensitivity for a large number of elements and its distinctly quantitative nature, high-flux neutron activation analysis is the method of choice for the determination of a large number of biological trace elements and the only applicable method for many. High-neutron-flux nuclear reactor facilities are already widespread and are becoming increasingly available for high-flux neutron activation analysis studies. Where a biological or medical research group does not have its own reactor, it can readily carry on such trace-element neutron activation analysis studies by irradiating samples in a nearby nuclear reactor facility or by using the services of an organization that provides a regular high-flux activation analysis service. (auth)

11451 (ORO-2980-18) NUCLEAR TECHNIQUES IN ON-STREAM ANALYSIS OF ORES AND COAL. Rhodes, J. R.; Berry, P. F.; Sieberg, R. D. (Texas Nuclear Corp., Austin). Sept. 26, 1968. Contract AT(40-1)-2980. 90p. Dep. CFSTI.

The on-stream nuclear analysis facilities set up at Texas Nuclear Corporation are described, along with investigations of the feasibility of continuous neutron activation analysis of coal, bauxite, cement raw mix, tar sands, taconite concentrate, and copper ore as bulk solids and of taconite concentrate as aqueous slurries, using an accelerator neutron generator. Pilot-plant trials of continuous neutron activation analysis of copper ores as bulk solids, using a neutron generator are described. Investigation was made of the feasibility of on-stream determination of silicon and aluminum in taconite concentrate, cement raw mix and bauxite as aqueous slurries, using radioisotope neutron sources. On-stream radioisotope x-ray fluorescence determination of calcium and iron in cement raw mix was investigated, and a new form of neutron activation by sample recirculation is studied. (auth)

11452 AUTOMATIC ACTIVATION ANALYSIS IN THE MINING INDUSTRY. APPLICATION TO IRON ORES. Perdijon, J. Rev. Ind. Minerale, 50: 205-10(Mar. 1968). (In French).

After a reminder of the principle of radio-activation analysis (neutron irradiation, transfer of the sample from the irradiation station to the counting station and counting of the gamma rays), an example of the determination of the iron, silica, and alumina contents of iron ores is given. (Sum. Articles Fr. Tech. Press)

11453 NEUTRON ACTIVATION ANALYSIS. Quittner, Pal (State Inst. of Nuclear Research, Budapest). Magy. Fiz. Foly., 16: 421-68(1968). (In Hungarian).

Modern industrial research, such as the preparation of ultrapure materials for semiconductors, and determination of biological trace elements, requires highly sensitive methods of analysis. One of the analytical methods available at present is the activation analysis. The irradiation techniques and the usual radiation sources are reviewed. Among the separation methods, solvent extraction, chromatography, precipitation, electrolytic separation, distillation, and isotopic exchange techniques are summarized briefly. The efficiency of radiation measurement methods are also reviewed; scintillation and semiconductor detectors are compared and the sources and methods of elimination of errors are identified. The computer programs developed for direct calculation of composition from experimental data are indicated. (Review article, 127 references). (TTT)

11454 PHOTOACTIVATION OF ALKALINE EARTH METALS AND ITS APPLICATION TO THE DETERMINATION OF STRONTIUM IN CALCIUM AND BARIUM. Abe, Shigeki (Yamagata Univ., Japan). Yamagata Daigaku Kiyo, Shizenkagaku, 7: 35-42 (Jan. 1968). (In Japanese).

Nondestructive methods for determination of Sr in Ca and in Ba were established, utilizing the results of photoactivation of alkaline earth metals. Alkaline earth metal sulfates were irradiated for 0.5 or 3 hr with 20-MeV bremsstrahlung produced from the JAERI linear accelerator. The γ spectrum of photoactivated Sr had a prominent photopeak of ^{87m}Sr at 0.39 MeV, with a half-life 2.84 hr. In the γ spectrum of irradiated Ca, the intense photopeaks of ^{43}K and ^{47}Ca$-^{47}$Sc, produced by the (γ,p) reaction of ^{44}Ca and the (γ,n) reaction of ^{48}Ca, were observed at 0.37 and 0.16 MeV, respectively. In the Ba, the ^{135m}Ba photopeak of 0.27 MeV, with a half-life 29 hr, was observed. For determination of Sr in Ca and Ba, the ^{43}K and ^{135m}Ba activity, respectively, were used as an internal monitor of photon flux intensity. The photopeak activity ratio ^{87m}Sr/^{43}K or ^{87m}Sr/^{135m}Ba vs. the wright ratio Sr/Ca or Sr/Ba were plotted, and the linear relationship was obtained. Strontium in Ca and in Ba was determined nondestructively to about 0.1%. (NSA of Japan)

11455 ACTIVATION ANALYSIS OF HIGH-PURITY SILICON FOR SEMICONDUCTOR USE. Motojima, Kenji (Japan Atomic Energy Research Inst., Tokyo); Nakayama, Ryoji. Bunseki Kiki, 6: 567-72(Sept. 1968). (In Japanese).

The activation analysis of semiconductor silicon for its impurities was performed using a high thermal-neutron flux. The impurities were elements in Group III and V, heavy metals, and elements introduced in the process of its preparation. The highly active sample material could be treated safely and rapidly. The impurities in silicon were analyzed with very high sensitivity. (NSA of Japan)

11456 APPLICATION OF NONDESTRUCTIVE ACTIVATION ANALYSIS TO METEORITES: DETERMINATION OF ALUMINUM, VANADIUM, MANGANESE, AND GOLD IN STONY AND IRON METEORITES. Hoefler, H.; Sorantin, H. Chem. Geol., 2: 273-8(1967).

The contents of Al, V, Mn, and Au in Mocs, Holbrook, Waconda, Knyahinya, Skobanja, Stannern, San Cristobal, Kenton County, and Arva Magura meteorites were determined by nondestructive activation analysis. Techniques are discussed and data are tabulated. (Geophys. Abstr.)

11457 ACTIVATION ANALYTICAL DETERMINATION OF ELEMENTS IN METEORITES. Schaudy, R.; Kiesl, W.; Hecht, F. Chem. Geol., 2: 279-87(1967).

A method of neutron activation analysis is reported for determination of Mn, Na, Ga, Cu, Au, and Cr in seven stony meteorites (Mocs, Holbrook, Waconda, Knyahinya, Long Island, Skobanja, Stannern) and three irons (Kenton County, San Cristobal, and Arva Magur), using finely powdered meteoritic material. Analytical data are tabulated. Specimens were from the Viennese Museum of Natural History. (Geophys. Abstr.)

11458 NEUTRON ACTIVATION ANALYSIS OF VANADIUM. Kurosawa, Ryuhei (Waseda Univ., Tokyo). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 41, 1-10(Sept. 1968). (In Japanese).

The nondestructive determination of V concentrations in various materials, such as petroleum, boiler scale, catalyzer, waste and others, was studied by neutron activation analysis. V was determined by direct γ spectrometry of ^{52}V in the irradiated samples. The samples were irradiated with the small size neutron generator device or TRIGA type reactor. The interference of ^{55}Mn(fast n,α)^{52}V in the determination of vanadium concentration is negligibly small. In order to estimate the ratio of fast to thermal neutron flux, the photo peak counts of ^{51}Ti produced by ^{51}V(fast n,p)^{51}Ti reaction was compared with that of ^{52}V produced by ^{51}V(thermal n,γ)^{52}V reaction. The content of V in various samples determined by the proposed activation method agreed with the results given by chemical analysis. The γ activity of irradiated V is compared with that of ^{40}K in natural K compound to estimate the sensitivity of activation analysis for V with small isotopic neutron source. According to the comparison, sensitivity of the proposed method can be determined as follows. When a 5″ ϕ × 5″ NaI scintillation detector and 10 Ci ^{241}Am−Be neutron source, and a 1¾″ ϕ × 1″ NaI detector and 13 Ci ^{241}Am−Be neutron source is used for activation analysis, the lower determination limits are 0.5 and 10 mg, respectively. (NSA of Japan)

11459 DETECTION OF TRACE IMPURITIES IN STOICHIOMETRIC SPINEL CRYSTALS BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Cloete, F. L. D.; Ortega, R. F.; White, E. A. D. (Imperial Coll. of Science and Tech., London). J. Mater. Sci., 4: 21-4(Jan. 1969).

High-quality doped crystals of stoichiometric spinel grown from solution in lead fluoride were subjected to neutron activation analysis to determine rare earth doping levels. The results showed that the small rare earth ion, Er^{3+}, can be incorporated to a small extent, but the larger Nd^{3+} ion is rejected. Contamination of the crystals with iridium was disclosed. This impurity was derived from iridium in the platinum crucibles used to contain the melts at high temperatures. No measurable platinum contamination was found. (auth)(UK)

11460 RADIO ACTIVATION ANALYSIS OF TRACE ELEMENTS IN REFINED SOYBEAN OILS. 2. DETERMINATION OF COPPER AND ZINC. Shinbori, Yoshio; Tamachi, Toshio. Yukagaku, 17: 606-10(Nov. 1968). (In Japanese).

The determination of Cu and Zn in refined soybean oils by neutron activation analysis followed by radiochemical purification of the resulting radioactive Cu and Zn was investigated. After neutron irradiation of the oils in a TRIGA-II small reactor, Cu and Zn were chemically separated, Cu by the salicylaldoxime precipitation method and Zn by the quinaldate precipitation method. The sensitivity limit of detection of this method is $\times 10^{-9}$ g for Cu and 10^{-8} g for Zn when sample weighing 1 to 3 g is irradiated for maximum 30 hr in a thermal neutron flux about 10^{11} n/cm^2/sec. (NSA of Japan)

11461 INVESTIGATION OF ACTIVATION ANALYSIS OF TRACE MERCURY IN GAS BY RADIOISOTOPE TRACER METHOD. Nishimura, Kunio; Hirayama, Tohru. Radioisotopes (Tokyo), 17: 562-8(Dec. 1968). (In Japanese).

A method was established using radioisotope tracer techniques and neutron activation analysis for the determination of trace mercury in gas. Analytical results were compared to those obtained by the dithizone and gas detector tube method. The absorbent was saturated chlorine solution and the absorption time was 2 hrs. After absorption, 4 ml of concentrated HNO_3 was added to the absorbent, and the mixture concentrated to 8 ml, then it was sealed in a quartz capsule. Irradiation was carried out in HTR with neutron flux of 1.2×10^{11} n/cm$^2 \cdot$sec for 5 hr. After cooling for 100 hr., samples were taken from the capsule and determined by the nondestructive method. The sensitivity of this method is 10^{-3} mg/m^3. The sensitivity can be improved by using higher neutron fluxes and destructive methods. (NSA of Japan)

11462 AVERAGE CROSS SECTIONS IN CHARGED PARTICLE ACTIVATION ANALYSIS. Meijers, P.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta, 10: 175-6(Dec. 1968).

Measurements made in activation analysis with charged particles are normally interpreted by means of the average cross section, σ, for a certain reaction. Equations for this purpose are discussed. (P.C.H.)

11463 CONTRIBUTION TO THE STUDY OF DETERMINATION BY RADIOACTIVATION OF S AND P IN VERY WEAK CONCENTRATIONS IN METALS OF VERY HIGH PURITY (Al, Mg, Cu, Fe, Ni). NEW SOURCE OF ERROR IN THE DETERMINATION OF S AFTER IRRADIATION BY THERMAL NEUTRONS. PART III. Albert, Ph.; Blouri, J.; Cleyrergue, Ch.; Deschamps, N.; Le Hericy, J. (CNRS, Vitry, France). J. Radioanal. Chem., 1: 431-41(Nov. 1968). (In French).

The chemical separation of sulfur and phosphorus from pure iron and nickel, is described. Sulfur was determined first by irradiation in fast neutrons, then by irradiation in mixed fast and thermal neutrons. The two methods gave different results. It was found that abnormal amounts of sulfur came from external contamination with chlorine since sulfur is produced by the $^{35}Cl(n,p)^{35}S$ reaction. The diffusion of ^{35}S atoms (produced on the edge of the samples) explains that the concentration of sulfur decreases from the edge to the middle of the sample. Samples of iron and nickel, artificially covered with ammonium chloride, were prepared and the apparent concentration of sulfur as a function of the depth in these samples was studied. The contamination in sulfur yielded by the (n,p) reaction, reached the middle of the samples very quickly. This phenomenon limits the determination of sulfur by the $^{34}S(n,\gamma)^{35}S$ reaction, in nickel and iron. (auth)

11464 INSTRUMENTAL AND RADIOCHEMICAL NEUTRON ACTIVATION ANALYSIS TECHNIQUES FOR PROTEIN BOUND TRACE METALS IN HUMAN SERUM. Fritze, K.; Robertson, R. (McMaster Univ., Hamilton, Ont.). J. Radioanal. Chem., 1: 463-73(Nov. 1968).

Gel filtration and neutron activation analysis methods were combined in work aimed at the development of methods for the determination of metals firmly bound to protein in human blood serum. The values obtained are semiquantitative. A purely instrumental technique afforded data on Cu, Fe, Zn, Al, and Mn but values for the latter two only were determined since Cu, Fe, and Zn are already well known The concentrations for Al and Mn were found to be 300 ppB and 0.4 ppB, respectively. Despite the high resolution of Ge(Li) detectors, no other metals were found. For the determination of any others, radiochemical separations are necessary and were used to obtain data on the following elements: As 3 ppB, Ag 3 ppB, Au 0.003 ppB, Cr 1 ppB, Sb 1 ppB, Co, Cd, Mo, and Sn could not be detected and upper limits were estimated to be 0.1 ppB, 2 ppB, 2 ppB, and 1 ppB, respectively. (auth)

11465 MEASUREMENT OF FIBER BLEND VARIABILITY BY ACTIVATION ANALYSIS. Armstrong, A. A. Jr. (Univ. of New Mexico, Albuquerque); Bogdan, J. F.; Chudgar, A. J. J. Radioanal. Chem., 1: 475-85(Nov. 1968).

The modern trend in textiles is to blend various fibers having different fiber properties to produce yarn and fabric with certain desired physical and chemical properties. The quality of blended yarn and the resulting fabric depends upon the uniformity of blending. In spinning yarns from blends of two or more staple fibers there is no convenient method of measuring the variability of each fiber. It was demonstrated that activation analysis could be used to measure the lengthwise variability of polyester fiber in a cotton-polyester blend at each step of the spinning process. (auth)

11466 APPLICATION LIMITS OF THE DOUBLE IRRADIATION TECHNIQUE IN THE DETECTION OF NUCLEAR INTERFERENCE REACTIONS. Op de Beeck, J.; Hoste, J. (Ghent Univ.). J. Radioanal. Chem., 1: 455-61(Nov. 1968).

The double irradiation technique, which is used to detect the production of a given nuclide from different chemical elements, by two different reactions in a polyenergetic neutron flux, cannot be generally applied. The application limits were defined and calculated, based on the statistical fluctuation of the measured activities. The experimental verification and the practical applications of the calculated limits for activation analysis, and transmutation reaction cross-section studies are discussed. (auth)

11467 DETERMINATION OF SOME PRECIOUS METALS BY NEUTRON ACTIVATION ANALYSIS. Crocket, J. H.; Keays, R. R.; Hsieh, S. (McMaster Univ., Hamilton, Ont.). J. Radioanal. Chem., 1: 487-507(Nov. 1968).

A neutron activation procedure for the determination of Ru, Pd, Os, Ir, Pt, and Au in a single irradiation in silicate rocks, meteorites, and sulfide ores was developed. An alkali fusion was used to dissolve and mix 100 to 200 mg powder samples with appropriate carriers. The individual metals were separated and brought to a state of high radiochemical purity by distillation, ion exchange, and solvent extraction techniques. Precious metal activities were counted by both γ and β^- methods. The procedure was evaluated by replicate analyses of the granite and diabase rock standards, G-1 and W-1 and a Cu–Ni sulfide matte which had previously been analyzed by emission spectrographic and spectrophotometric methods. The results were compared with previously published data. A major discrepancy was found only for Ir in W-1. (auth)

11468 OPTIMAL DETECTION SENSITIVITIES IN ACTIVATION WITH FAST NEUTRONS FROM AN $^{241}Am–^{242}Cm–Be$ SOURCE. Wing, James; Wahlgren, Morris A. (Argonne National Lab., Ill.). Appl. Spectrosc., 23: 5-7(Jan.-Feb. 1969).

The detection sensitivities of 60 chemical elements in activation with the fast neutrons from an $^{241}Am-^{242}Cm-Be$ source were measured. The source consisted of six slugs with a total output of 4.8×10^9 unmoderated neutrons/sec, and a flux of 1.4×10^8 fast neutrons/sec-cm^2. In general, the sensitivity (counts in a selected photopeak per gram of target element) for each element was obtained with irradiation for two to three half-lives of the short product nuclide, and counting for the same length of time. Neither irradiation nor counting was longer than 1 h. The detector was a cylindrical thallium-activated sodium iodide crystal 10 cm long and 10 cm in diam. The measured sensitivities are compared with reported sensitivities in activation with thermal neutrons. (auth)

11469 DETERMINATION OF SILICON IN ROCKS BY FAST-NEUTRON ACTIVATION ANALYSIS USING INTERNAL STANDARDS. Santos, G. G.; Wainerdi, R. E. (Texas A and M Univ., College Station). J. Radioanal. Chem., 1: 509-14(Nov. 1968).

A technique for using internal standards in the determination of Si in rocks using fast-neutron activation is presented. Different weights of barium acetate were irradiated for 30 sec then cooled for 10 sec before counting for one min. A peak area, at 0.662 MeV due to ^{137m}Ba, versus weight of barium calibration curve (I) was made. Similarly, barium acetate, which served as the neutron flux monitor, was mixed with known weights of standard rocks, BCR-1 and G-2. Then a peak area (at 1.78 MeV due to ^{28}Al) versus weight of silicon (present in the standard rocks) calibration curve (II) was constructed which was corrected for flux variations. Flux corrections were made possible using curve (I). Utilizing curve (I) and curve (II) the percentage Si in granite samples obtained from Llano, Texas, was determined. This technique avoids any external neutron monitor or sample rotation system. The applicability of this approach may be limited to samples in which the internal flux monitor can be dispersed. (auth)

11470 EDGE-PUNCHED CARD LITERATURE RETRIEVAL SYSTEM FOR ACTIVATION ANALYSIS. Braun, T. (Eoetvoes Univ., Budapest); Bujdoso, E.; Miskei, M. J. Radioanal. Chem., 1: 515-21(Nov. 1968).

The activation analysis literature card system described can be used to obtain information rapidly and accurately on the following problems: activation analytical determination of certain elements, in general, in a given matrix, or in a given field; selection of activation publications by authors, by year, by character of paper, or by particle used for irradiation; and selection of publications on some major technical topic of activation analysis. The first approximately 5000 coded cards will be issued during 1969. (D.H.M.)

11471 ACTIVATION ANALYSIS OF TRACE ELEMENTS IN REFINED SOYBEAN OILS. III. DETERMINATION OF GOLD. Shinbori, Yoshio; Tamachi, Toshio (Musashi Inst. of Tech., Kawasaki, Japan). Radioisotopes (Tokyo), 18: 12-15(Jan. 1969). (In Japanese).

The determination of gold in refined soybean oils by neutron activation analysis is described. The method, which purifies radioactivated gold, consists of ashing the sample in a muffle furnace, dissolving the ash in mineral acid, and preparing solid samples by reduction. The activity of gold is measured by $\beta-\gamma$ coincidence and γ counting. The detection limit is 10^{-8} g for gold when the sample of 2 to 3 g is irradiated by a thermal neutron flux of about 10^{11} n/cm^2 · sec for a maximum of 30 hr. (auth)

11472 USE OF ION EXCHANGE COLUMNS SUPERIMPOSED IN ACTIVATION ANALYSIS. Ricq, J. C. (Atome Industriel, Grenoble, France). J. Radioanal. Chem., 1: 443-53(Nov. 1968). (In French).

Starting from a known scheme of separations by ion exchange resins, and having developed some eluants, it is possible to separate twenty-three elements without further handling than to pour the eluants into columns. Changes of medium after elution are avoided. The columns made with two kinds of resins are sometimes superimposed, in which case the eluate of the first column is used as eluant on the second column, and sometimes separated, in which case each column is treated separately. The scheme was applied particularly to the aluminum matrix, but matrices of stainless steel and niobium were treated in the same manner. From this versatile scheme, very simple and rapid separations may be possible. (auth)

11473 DETERMINATION OF PHOSPHORUS IN SILICATE ROCKS BY NEUTRON ACTIVATION. Greenland, L. Paul. U. S. Geol. Surv., Prof. Pap., No. 575-C, 137-40(1967).

Phosphorus was determined in eight U. S. Geological Survey standard rock reference samples by neutron activation. After a 2-hour irradiation of 10-mg samples, phosphorus is separated in a radiochemically pure form by cation exchange, molybdate precipitation, magnesia precipitation, and CuS scavenging. A final magnesia precipitation yields phosphorus in a form suitable for low-level β^- counting. Subsequently, the percentage of recovery for phosphorus is determined spectrophotometrically as the yellow molybdovanadophosphoric acid. The results found by this technique are in good agreement with conventional chemical analyses. (auth)

11474 MAJOR ELEMENT DETERMINATION IN GEOLOGICAL MATERIAL BY NEUTRON ACTIVATION ANALYSIS. Steinnes, Eiliv (Institutt for Atomenergi, Kjeller, Norway). Tidsskr. Kjemi, Bergv. Met., 29: 10-13(Jan. 1969). (In Norwegian).

A survey was made of major element determination in geological material by neutron activation analysis. Simple and accurate determination of aluminium, sodium, and manganese is easily performed by reactor neutron activation, and also for potassium and phosphorus convenient methods exist. Correspondingly oxygen, silicon, and aluminium can be advantageously determined by means of a neutron generator. (auth) (Norway)

11475 DETERMINATION OF NITROGEN IN PLANT MATERIALS BY FAST NEUTRON ACTIVATION ANALYSIS. Kosta, L. (Univ. of Ljubljana, Yugoslavia); Ravnik, V. Vestn. Slov. Kem. Drus., 14-15: No. 1-4, 5-14(1967-1968).

Activation by 14-MeV neutrons was applied to the determination of nitrogen in plant material using wheat flour, maize flour, and the respective grains as samples. A permanent calibration curve was constructed by irradiating a set of reference samples with varying concentration of nitrogen together with monitors in well-defined and reproducible geometrical conditions and plotting the ratio of the activity sample to monitor against nitrogen concentration. The precision of the technique is compared to that of the Kjeldahl method when using small samples ranging from 100 to 400 mg at nitrogen concentrations between 1 and 3%. (auth)

11476 STABLE CHROMIUM AS A TRACER FOR RED CELLS, WITH ASSAY BY NEUTRON ACTIVATION ANALYSIS. Johnson, P. F.; Tothill, P.; Donaldson, G. W. K. (Royal Infirmary, Edinburgh). Int. J. Appl. Radiat. Isotop., 20: 105-8(Feb. 1969).

The use of nonradioactive ^{50}Cr as a tracer is described, with particular application to the measurement of red cell survival time. The chromium content of serial blood samples was measured by neutron activation analysis. Many other radionuclides were produced, and chemical separation of the activated chromium gave the highest sensitivity of assay. Gamma ray spectrometry was used as an alternative procedure, and various methods of deriving the count rate due to ^{51}Cr from the pulse height distribution were investigated and compared. The method is useful for double tracer studies or when it is desirable to avoid a radiation dose to a patient. (auth) (UK)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 11530, 11589, 11607, 11628, 12279, 12340, 12393, 12404, 12414, 12440, and 12572.

11477 (AAEC/E-194) COMPOSITION AND STRUCTURE OF AMMONIUM URANATES. Stuart, W. I.; Whateley, T. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1968. 16p. Dep.

The ammonium uranate system was studied by thermal analysis, ion exchange measurements, and infrared spectroscopy. The results show that in all ammonium uranates, ammonia is combined as NH_4^+. Infrared results indicate that the ammonium uranate system is single-phase in which the NH_3 : U ratio can be varied continuously. In an aqueous environment the variation of composition occurs by a cation exchange mechanism. (auth)

11478 (AI-AEC-12721, pp 279-308) GENERAL CHEMISTRY AND CHEMICAL ENGINEERING. McKisson, R. L.; Eichelberger, R. L.; Gehri, D. C.; Guon, J. (Atomics International, Canoga Park, Calif.).

Progress is reported on sodium purification, the solubility of selected metals and nonmetals in liquid sodium, the nature of solute entities and their interactions in liquid sodium, and the analytical chemistry of solutes in liquid sodium. (M.C.G.)

11479 (AI-AEC-12721, pp 313-22) ADVANCED DEVELOPMENT PROGRAM. (Atomics International, Canoga Park, Calif.).

Research progress is reported on: supercritical conductivities of fused salts, electric conductivity of bismuth halides at high pressure, compressibilities and volumes-of-fusion of molten $BiCl_3$ and $AlCl_3$ at elevated pressures, polymorphic transitions in alkali halides, electric conductivity of pure $AlCl_3$, phase diagrams of $AlCl_3$-alkali metal chlorides, phase diagram of NaBr-$AlBr_3$, electric conductivity of $AlCl_3$-KCl and $AlBr_3$-NaBr systems, ionic salt vapors, solid-state galvanic cells, thermoelectric properties of metal-metal salt systems, and electric conductivity of CuCl-$CuCl_2$ and Hg-HgX_2 systems. (M.C.G.)

11480 (NYO-3991-2) NONLINEAR ELASTIC AND THERMOELASTIC PROPERTIES OF HIGH TEMPERATURE MATERIALS. Annual Progress Report. (Pennsylvania State Univ., University Park. Materials Research Lab.). Dec. 1968. Contract AT(30-1)-3991. 9p. Dep. CFSTI.

The pressure dependence of the three second-order elastic constants were measured for single crystals of RbCl, RbBr, and RbI at 300°K. The measurements were restricted to the pressure range below the phase transition from the NaCl to the CsCl structure. Similar measurements were performed for CsI. Methods are being considered for experimental determination of fourth-order elastic constants. Ultrasonic equations of state were calculated. (M.C.G.)

11481 ACID-CATALYZED HYDROLYSIS OF ETHYL VINYL ETHER. Eliason, Robert Walter. Minneapolis, Univ. of Minnesota, 1968. 91p.

Thesis.

The hydrolysis of ethyl vinyl ether is shown to obey the Brønsted Catalysis Law with a variety of carboxylic acids. The value of α for carboxylic acids is 0.66. Acids of other structure and charge type, i.e., H_3O^+, HSO_4^-, and H_3PO_4, give rates substantially varying from those predicted by the carboxylic acid correlation. The overall solvent isotope effect, k_H/k_D, was determined for a variety of acids. The values of k_H/k_D for H_3O^+, H_3PO_4, chloroacetic acid, and cyanoacetic acid are 3.20, 3.1, 6.2, and 4.2, respectively. The competitive isotope effect, $\mathcal{K}_H/\mathcal{K}_D$, was calculated from competitive T isotope effects, $\mathcal{K}_H/\mathcal{K}_T$, and the Swain-Schaad relations for several different acids. For H_3O^+, chloroacetic acid, and H_3PO_4 $\mathcal{K}_H/\mathcal{K}_D$ is 7.0, 5.2, and 5.5, respectively. If the model for the transition state structure involves no intervening solvent molecule between the transferring acid and the substrate, the proton transfer is directly from H_3O^+. This leads to a primary isotope effect, $(k_H/k_D)_I$, of 4.0 and a secondary, solvent isotope effect, $(k_H/k_D)_{II}$, of 0.66. From the latter an isotopic α, α_i, of 0.56 is obtained. An experimental test of the Swain-Schaad relations, $k_H/k_D = (k_H/k_T)^{0.693}$ and $k_D/k_T = (k_H/k_T)^{0.306}$, was made from measurements of the competitive T isotope effect, $\mathcal{K}_D/\mathcal{K}_T$ for H_3O^+ and chloroacetic acid. The Swain-Schaad relations were used to calculate $\mathcal{K}_D/\mathcal{K}_T$ from $\mathcal{K}_H/\mathcal{K}_T$. The experimental and calculated values for $\mathcal{K}_D/\mathcal{K}_T$ are 2.37 and 2.4 for H_3O^+ and are 2.08 and 2.1 for chloroacetic acid. The evidence presented suggests that the proton is slightly more than half transferred in the transition state. The reaction coordinate is largely proton transfer. The results also appear to be adequately interpreted by a model that requires no additional molecules in the transition state except the catalyzing acid and the substrate. The proton magnetic resonance shift of $H_2PO_4^-$ in H_2O-D_2O mixtures was studied. From this the fractionation factor, ϕ_2, for $H_2PO_4^-$ was calculated to be 0.875. From ϕ_2, ϕ_1 was calculated to be 0.739 and ϕ_3 to be 0.615. Data are presented which suggest that the model used for H_3PO_4 may be incorrect. (Diss. Abstr.)

11482 AMERICIUM(III)-SULPHATE COMPLEXES. Nair, G. M. (Bhabha Atomic Research Centre, Bombay). Radiochim. Acta, 10: 116-19(Dec. 1968).

The nature and stability of the complexes formed by Am(III) with sulfate ions in Na_2SO_4 and H_2SO_4 media at an ionic strength of unity and at 27°C were determined using a cation exchange technique. The stability constants for the complexes were calculated from the distribution coefficient data for Am(III) by least squares analysis. Anion exchange and electrical migration experiments were carried out in order to establish the nature of the higher complexes formed. The discrepancy in the stability constant values for the same species in different media at the same ionic strength is discussed. (auth)

11483 PRECIPITATION AND SOLUBILITY OF URANYL ORTHOPHOSPHATES. II. HETEROGENEOUS EQUILIBRIA IN SOLUTIONS OF: $UO_2(NO_3)_2-H_3PO_4-HNO_3$. Pavkovic, N.; Wrischer, M.; Branica, M. (Univ., Zagreb). Croat. Chem. Acta, 40: 127-30(1968).

The precipitation and dissolution of uranium(VI) from aqueous solutions containing $10^{-3}\underline{M}$ uranyl nitrate and various concentrations of orthophosphoric and nitric acid were surveyed. The concentration regions where $(UO_2)_3(PO_4)_2$ and UO_2HPO_4 are precipitated and/or dissolved are presented by means of typical precipitation bodies. The influence of the initial concentration ratio of nitric/orthophosphoric acid in the precipitation system on the morphology of $(UO_2)_3(PO_4)_2$ particles formed is shown by electron micrographs. (auth)

11484 PRECIPITATION AND SOLUBILITY OF URANYL ORTHOPHOSPHATES. I. HETEROGENEOUS EQUILIBRIA IN SOLUTIONS OF: $UO_2(NO_3)_2-H_3PO_4$. Pavkovic, N.; Branica, M.; Tezak, B. (Univ., Zagreb). Croat. Chem. Acta, 40: 117-25(1968).

The precipitation and dissolution of uranium(VI) from aqueous solutions of orthophosphoric acid (2×10^{-4} to $6\underline{M}$) and uranyl nitrate (3×10^{-5} to $0.5\underline{M}$) were investigated by turbidimetric and chemical analyses, fluorescent and electron microscopy. The concentration ranges where $(UO_2)_3(PO_4)_2$ and UO_2HPO_4 precipitates were observed 24 hours and 30 days after mixing are represented by typical precipitation bodies. The morphology of the precipitated particles is shown by electron micrographs. At equilibrium conditions $(UO_2)_3(PO_4)_2$ is stable at concentrations of total phosphate in the mother liquor lower than $1.5 \times 10^{-3}\underline{M}$. At total phosphate concentrations higher than $5 \times 10^{-3}\underline{M}$, UO_2HPO_4 is stable. (auth)

11485 EFFECTS OF IONIC RADIUS AND ORGANIC DILUENTS ON THE EQUILIBRIUM PHENOMENA OF SOME LANTHANIDE THIOCYANATE-TBP ADDUCTS. Nakamura, Keikichi (National Research Inst. for Metals, Tokyo). J. Inorg. Nucl. Chem., 31: 455-65(Feb. 1969).

Adducts of lanthanide thiocyanates and tributyl phosphate (TBP) were prepared by the action of TBP on solid thiocyanates and the resultant solutions examined by infrared spectroscopy to determine the stability constants of the adducts. Cyclohexane, carbon tetrachloride, and benzene were employed as diluents for the TBP. The results showed a variation in the number of TBP molecules solvating the lanthanide thiocyanates and while a solvation number of 3 to 4 was observed for yttrium and the heavier lanthanides (i.e., erbium and dysprosium), 4 to 5 was obtained for the lighter lanthanides (i.e., lanthanum and cerium). The stability constants of the adducts, $K_{3,4}$ and $K_{4,5}$, increased numerically with increasing ionic radius of the lanthanides, and the magnitude of the individual stability constants depended on the choice of diluents. The order of stability constants with respect to the ionic radius was the opposite of that found for lanthanide complexes in aqueous solution. Where a single lanthanide thiocyanate-TBP species was present in solution, a splitting of the P = O stretching band was attributed to the presence of more than one ligand isomer, and the relative amount of the two isomers appeared to depend on the ionic radius of the central metal ion, the solvation number and the nature of the diluent employed. (auth)(UK)

11486 THERMAL DECOMPOSITION OF URANYL ACETATE. Clough, P. S.; Dollimore, D.; Grundy, P. (Univ. of Salford, Eng.). J. Inorg. Nucl. Chem., 31: 361-70(Feb. 1969).

The thermal decomposition of uranyl acetate in nitrogen and air was studied. The decomposition residues were identified and the kinetics of the decomposition established. The changes in specific surface area and density during decomposition were followed and a possible decomposition mechanism is suggested. (auth)(UK)

11487 RAPID ISOTOPIC EXCHANGE BETWEEN IODOMETHYLTRIMETHYLTIN AND IODIDE IONS IN ACETONE. Norling, Eva; Beronius, Per (Univ. of Umea, Sweden). Radiochim. Acta, 10: 153-5(Dec. 1968).

The isotopic exchange between iodomethyltrimethyltin and sodium iodide ($^{131}I^-$) in anhydrous acetone has been investigated by means of electroanalysis. Measurements were carried out in the temperature interval 5 to 35°C at total reactant concentrations varying from 4×10^{-4} to 15×10^{-4} $\underline{M}$. Under these conditions the half-times of exchange varied from 8 seconds to 3 minutes. The Arrhenius activation energy is 15.7 kcal mole^{-1} and the activation entropy 0.6 cal degree^{-1} mole^{-1} at 25°C. (auth)

11488 DIFFUSION OF THORON IN HELIUM. Schiffgens, John O'Neil. University Park, Pa., Pennsylvania State Univ., 1968. 128p.

Thesis.

A diffusion apparatus that can be used to measure continuously the time-dependent diffusion of a decaying gas in a binary gas mixture over a temperature range from room temperature to 600°C was built and used to study the diffusion of radon (thoron) in He as a function of temperature up to 254°C. The diffusion apparatus consists of a diffusion tube, a constant temperature furnace, and a ZnS α scintillation detector with ratemeter. A constant source of thoron atoms is introduced through a valve into the closed end of the He-filled diffusion tube. Thoron atoms diffusing out of the open end of the tube are picked up by carrier He flowing past the open end and through the scintillation detector. Thoron diffusion coefficients are determined from the measured thoron current at the open end of the diffusion tube by fitting the curve of detector counting rate versus time to a theoretical model. The model is based on the solution to the one dimensional, time dependent diffusion equation for thoron in the tube, the response of the detector to thoron α activity, and the response of the ratemeter to the detector input. The diffusion coefficients determined with this apparatus increase with temperature approximately as $T^{3/2}$, which is the temperature variation predicted by the rigid sphere potential. The ratio $D/T^{3/2}$ should rise slowly with temperature in this temperature range because intermolecular potentials, such as Lennard-Jones, are more realistic. Either the theory of the apparatus is incomplete or unknown experimental errors prevent the expected slow rise in the $D/T^{3/2}$ ratio with temperature. If the method is to be used to obtain the intermolecular potential of the helium-thoron pair, the apparatus must be examined more carefully to see if a better theoretical model can be devised and experimental errors reduced. (Diss. Abstr.)

11489 KINETICS OF THE THERMAL DECOMPOSITION OF CYCLOPENTENE AND HYDROGEN ISOTOPE EFFECT. Knecht, Dieter August. New York, Univ. of Rochester, 1968. 195p.

Thesis.

The thermal decomposition of cyclopentene was studied in the gas phase at 479 to 520°C with pressures in the range 4 to 34 mm. A sample of deuterated cyclopentene (72.4% C_5D_8, 23.3% C_5D_7H, 3.7% $C_5D_6H_2$, and 0.6% $C_5D_5H_3$) was decomposed in the temperature region from 490 to 530°C at pressures of about 5 to 30 mm. In the initial phases the pyrolyses of both the light and heavy cyclopentenes proceed predominantly to give light or heavy hydrogen and cyclopentadiene, but at greater extents of decomposition the participation of minor reactions increases. The dehydrogenation reaction appears to be a first-order process. The activation energy of 57.7 kcal mole^{-1} is comparable to earlier reported values. The pre-exponential factors of the Arrhenius expressions for the pressure-increase and dehydrogenation of cyclopentene were 0.63×10^{13} and 0.59×10^{13} sec^{-1}, respectively. Gas chromatographic and mass spectrometric analyses showed the presence of small amounts of ethylene and propylene. An approximately three-fold greater rate of reaction of light cyclopentene compared to heavy cyclopentene near 500°C was indicated by the results from pressure measurements for the pyrolysis of separate samples and copyrolysis experiments in which the relative rates of formation of the hydrogen isotopes, as well as isotopic cyclopentadienes, were determined. The deuterated cyclopentene was found to have an activation energy of about 2.5 kcal mole^{-1} higher than that of light cyclopentene. Mass spectrometric analyses of the reaction mixtures from the copyrolysis of light and heavy cyclopentenes were made over the region 480 to 520°C at various stages of the decomposition and especially at a reaction time producing about 5% decomposition of C_5H_8 and 1.7% decomposition of C_5D_8. For the latter conditions the dehydrogenation process appears to be mainly the elimination of a molecule of hydrogen with atomic reactions contributing not more than one-thirtieth of the total hydrogen isotopes formed. In the copyrolysis experiments the minor product ethylene was observed to have experienced a negligible amount of isotopic mixing during its formation, whereas propylene exhibited a significant degree of isotopic mixing. (Disser. Abstr.)

11490 CHARGE TRANSFER THEORY OF THE H_2–D_2 EXCHANGE ON MgO. Shang, William Wu. Houston, Tex., Rice Univ., 1968. 125p.

Thesis.

Catalytic activity of MgO powder for the H_2-D_2 exchange reaction was studied as a function of the surface irradiation with controlled frequencies of uv radiation from a monochromator. A succession of uv energies from 3 to 7 eV was applied to the surface and the relative enhancement of the first-order rate constant produced at saturation for each frequency was plotted against the uv energy. The relative enhancement of the rate constant shows well-defined peaks at 5.7, 4.9, and 4.0 eV. By comparison with work of other investigators on optical absorption, photoconductivity, and electron paramagnetic resonance studies on MgO irradiated with uv, it is possible to state quantitatively the energy of the electronic transitions affecting the catalysis and, in some cases, to identify the physical nature of the excitation. This technique constitutes a reaction-rate spectrometer and should be useful in studying electronic factors in other insulator and semi-conductor catalytic surfaces. (Diss. Abstr.)

11491 CHEMISTRY OF LANTHANONS. XIX. ETHYLENEDIAMINE BIS-ACETYLACETONE COMPLEXES OF RARE-EARTHS. Dutt, N. K.; Nag, K. (Indian Association for the Cultivation of Science, Calcutta). J. Inorg. Nucl. Chem., 30: 3273-80(Dec. 1968).

Ethylenediamine bis-acetylacetone (enac) complexes of rare earths are described. Compounds of composition $Ln(enac)_2 X_3$, where Ln = La, Ce, Pr, Nd, or Sm and X = Cl^-, NO_3^-, or SCN^-; and $Ln_2(enac)_3 X_6$ where Ln = Gd, Dy, Er, or Y and X = Cl^- or NO_3^- were obtained. On the basis of their uv visible, and ir spectra, and also from conductance and molecular weight measurements, possible structures for the complexes are proposed. (auth)(UK)

11492 OXIDATION CATALYSTS AND METHODS FOR THEIR PREPARATION. Bressat, Rene; Claudel, Bernard; Trambouze, Yves; de Calmes, Alain (to Commissariat a l'Energie Atomique). British Patent 1,137,663. Dec. 27, 1968. Priority date Dec. 8, 1964, France.

An oxidation catalyst suitable for post-combustion of exhaust gases consists of a mixed oxide of Th and U having a formula $U_xTh_{1-x}O_{2+y}$ in which x is smaller than 0.35 and y is in the range 0 to 0.3. The catalyst is prepared by forming either a complex oxalate of NH_4^+, U, and Th or a mixed oxalate of U and Th and heating the complex or mixed oxalate at a decomposition temperature in the range from 400 to 500°C. The catalyst so produced has crystalline lattice parameter in the range of 5.55 to 5.59 Å and belongs to the face-centered cubic system. (B.L.M.)

11493 NEPTUNIUM(VII), NOBELIUM(II), 126(IV), AND OTHER UNEXPECTED OXIDATION STATES OF TRANSURANIUM ELEMENTS. Joergensen, C. K. (Cyanamid European Research Inst., Geneva). Chem. Phys. Lett., 2: 549-50(Dec. 1968).

The relative stability of oxidation states in the 5f and 4f groups and predictions for the 5g group are related to spectroscopic quantities and the phenomenological baricenter polynomial. (auth)

11494 SOME LANTHANIDE COMPLEXES OF CYCLIC AMIDES. Miller, W. V.; Madan, S. K. (State Univ. of New York, Binghamton). J. Inorg. Nucl. Chem., 30: 3287-94(Dec. 1968).

The syntheses and physical properties of the crystalline compounds $[Ln(BuL)_8](ClO_4)_3$, where Ln = La, Pr, Nd, Sm, Gd, Dy, Er, Yb, or Y and BuL = γ-butyrolactam); $[Ln(NMBuL)_8](ClO_4)_3$, where Ln = La, Pr, Nd, Sm, or Gd] and NMBuL = N-methyl-γ-butyrolactam; and $[Ln(NMBuL)_7](ClO_4)$ where Ln = Dy, Er, Yb, or Y are reported. For most of the complexes the ir, visible, and uv spectra are reported, as well as the magnetic susceptibilities, molar conductivities, x-ray powder patterns, and molecular weights. Both the composition of these compounds and the x-ray data indicate clearly the existence of two isomorphous series of NMBuL-complexes, one including compounds of the formula $[Ln(NMBuL)_8](ClO_4)_3$ and other compounds of the formula $[Ln(BuL)_7(ClO_4)_3]$. (auth) (UK)

11495 ISOTOPE EFFECTS IN THE DIFFUSION OF ^{12}C- AND ^{14}C-SUBSTITUTED MOLECULES IN THE LIQUID PHASE. Eppstein, L. B. (Texas Christian Univ., Fort Worth). J. Phys. Chem., 73: 269-70(Jan. 1969).

Intradiffusion coefficients for several binary systems have been reported in which the observed intradiffusion coefficient of the solute at infinite dilution is greater than the limiting mutual-diffusion coefficient of the system. The ratio of the mutual-diffusion and intradiffusion coefficients at infinite dilution may be written as $D^0/D^+ = (M^+/M^0)^{1/2}$, where D^0 is the limiting mutual-diffusion coefficient, D^+ is the intradiffusion coefficient at infinite dilution, M^+ is the molecular weight of the isotopically substituted species, and M^0 is the molecular weight of the unsubstituted species. The deviations of the observed limiting intradiffusion coefficients from the values predicted by the above equation were rationalized with the inclusion of a correction for a systematic error arising from "surface effects" in the calibration of the diaphragm cell. Corrected limiting intradiffusion coefficients are compared with values calculated from the equation for thiourea, mannitol, sucrose, benzene, cyclohexane, alanine, and urea. There was agreement between the calculated and corrected D^+ in all cases within the estimated experimental error of the measurements. (D.H.M.)

11496 THE DETERMINATION OF THE SPECTROSCOPIC CONSTANTS OF THE PERPENDICULAR INFRARED FUNDAMENTALS OF MONODEUTEROMETHANE. Leisegang, E. C.; Parkyn, D. G. J. S. Afr. Chem. Inst., 21: 64-71(Apr. 1968).

The observed perpendicular ir absorption bands of monodeuteromethane reported in earlier publications were evaluated by interpretations of the fine structures of the bands, and on the application of combination sum and difference plot methods for determining the spectroscopic constants. Such regression procedures involve the simplifying assumption of average values for the centrifugal distortion coefficients, giving inaccurate estimates for vibrational frequencies, rotational constants, and Coriolis coefficients. Computer regression analysis was applied to the problem. Spectroscopic constants (cm^{-1} units except ζ', which is dimensionless) for the ν_4 band of monodeuteromethane are given: ν_0, 3016.423; A', 4.84710; A'', 4.86551; B', 3.87605; B'', 3.89206; D_J', 1.22×10^{-4}; D_J'', 1.70×10^{-4}; D_{JK}', 1.82×10^{-4}; D_{JK}'', 2.09×10^{-4}, D_K', -3.77×10^{-5}; D''K, -4.11×10^{-5}; ζ', 0.00331. Values for the ν_5 and ν_6 bands are respectively: ν_0, 1474.89, 1157.72; A', 6.7294, 5.2951; A'', 6.8026, 5.3073; B', 3.8674, 3.8060; B'', 3.8892, 3.8683; D_J', 1.1×10^{-4}, -3.5×10^{-5}; D_J'', 1.1×10^{-4}, -1.4×10^{-4}; D_{JK}', 4.1×10^{-4}, 1.03×10^{-3}; D_{JK}'', 5.1×10^{-4}, 9.2×10^{-4}; D_K'; 2.7×10^{-5}, 4.2×10^{-5}; D_K'', 5.52×10^{-4}, -4.64×10^{-4}; ζ', −0.0147, 0.0102; σ, 0.88, 0.16. The ratio of A'' to B'' for the ν_4 band is close enough to the expected tetrahedral value to give confidence in the general analysis. In principle, the differences between the C–D bond and the C–H bond should be detectable. The P and R structure of ν_4 is so clear as to merit further study. The computer regression techniques devised for this work in conjunction with an averaging technique applied to replicate spectra may yield a precision capable of determining any significant differences in bonding between D and H. (BBB)

11497 ON THE FLUORINATION OF PROTACTINIUM. Laser, M.; Merz, E. (Kernforschungsanlage, Juelich, Ger.). J. Inorg. Nucl. Chem., 31: 349-60(Feb. 1969). (In German).

Protactinium-233, formed by thermal neutron activation of thorium, can be volatilized from irradiated compounds applying fluorination with gaseous fluorine, hydrogen fluoride, or sulfur hexafluoride. For nearly complete volatilization, however, temperatures above 800°C are necessary when using fluorine or hydrogen fluoride, and above 1000°C, when sulfur hexafluoride is applied as fluorinating agent. Since at these temperatures thorium tetrafluoride possesses a noticeable vapor pressure, only a limited enrichment of protactinium is achievable. The behavior of carrier-free deposited ^{233}Pa is discussed. Taking the present and earlier experimental results into consideration, the thermodynamic data of the compounds in the system Pa–O–F were estimated. Values are given for Pa_2O_5, $PaO_{2.3}$, PaO_2, $PaOF_3$, Pa_2OF_8, PaF_5, and PaF_4. From these data the thermodynamic phase diagrams were evaluated. (auth) (UK)

11498 AMERICIUM AND NEPTUNIUM BORIDES. Eick, Harry A.; Mulford, R. N. R. (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem., 31: 371-5(Feb. 1969).

The neptunium and americium boride systems were examined by x-ray powder diffraction techniques. In the neptunium–boron system four phases, NpB_2, NpB_4, NpB_6, and NpB_{12}, were observed, while in the americium–boron system only two phases, AmB_4 and AmB_6, were found. Lattice parameters and thermal stability data are presented and discussed. (auth) (UK)

11499 CHEMICAL BONDING OF THORIUM MONOCARBIDE. Satow, Tsuneo; Tamaki, Shigeru (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 6: 1-5(Jan. 1969).

The magnetic susceptibility of nonstoichiometric thorium monocarbide having compositions between $ThC_{0.72}$ and $ThC_{0.96}$ was measured at various temperatures. The susceptibility showed weak paramagnetism independent of temperature, which increased with decreasing carbon content ($\chi_{mole} = 6.0 \times 10^{-5}$ emu for $ThC_{0.72}$, 4.1×10^{-5} emu for $ThC_{0.96}$). The bonding of Th−Th, Th−C, and C−C is discussed with the aid of a metallic bonding model applied to the compound. The bond energies of Th−Th and Th−C were analyzed on the basis of Pauling's scheme, and evaluated to be −51 kcal/mole and −271 kcal/mole respectively, at a composition of $ThC_{0.96}$. The narrow band of ThC is examined from measured results of magnetic susceptibility. (auth)

11500 DIISOPROPYL-N, N-DIETHYLCARBAMYLPHOSPHONATE COMPLEXES WITH LANTHANIDE NITRATES AND CHLORIDES. Stewart, W. E.; Siddall, T. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Inorg. Nucl. Chem., 30: 3281-5(Dec. 1968).

Solid adducts of lanthanide nitrates and chlorides with diisopropyl N,N-diethylcarbamylphosphonate were prepared and studied. The La, Ce, Pr, Nd, Sm, Gd, and Tb nitrate adducts were isolated and the structure determined. The Dy, Er, Ho, and Yb nitrate adducts were difficult to isolate and were found to have no single, discrete structure. The chloride adducts of La, Pr, Sm, and Tb were isolated and assigned a structure. (auth) (UK)

11501 SULFATE ION EXCHANGE BETWEEN RADIOACTIVE CRYSTALS AND A SATURATED $BaSO_4$ SOLUTION. Gromov, V. V.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 183: 368-70(Nov. 11, 1968). (In Russian).

Studies were made of sulfate ion exchange between radioactive $BaSO_4$ crystals and saturated nonradioactive solution of barium sulfate in water. The exchange ratio was determined by radioactivity variations in the liquid phase (50 ml, pH 4.5 to 6) in contact with 0.1 g crystals varying in size from 1 to 4μ. The experiments were carried out using as a pure β emitter ^{35}S with $E_{max} = 0.167$ MeV and $T_{1/2} = 87.1$ days. In the conical retort with intensive mixing and constant volume of the liquid phase the temperature was kept steady at 25 + .01°C. Graphical data on the variation of general rate of exchange as a function of specific radioactivity of barium sulfate show that the rate of exchange increased with the increase of $BaSO_4$ radioactivity. Heating of $BaSO_4$ crystals to ~350°C smoothed radioinduced defects and slowed the rate of exchange. The rate of exchange in thermally treated specimens was identical notwithstanding their specific radioactivity. (R.V.J.)

11502 PREPARATION OF URANIUM CARBIDE FROM URANIUM CHLORIDE. Mukaibo, Takashi; Kanno, Masayoshi (Tokyo Univ). Tokyo Daigaku Kogakubu Kiyo, A, No. 5, 48-9(Nov. 1967). (In Japanese).

A method was developed for preparation of uranium monocarbide using UCl_4 as starting material. Among several thermodynamically possible reactions, the reaction of UCl_4, Al, and graphite powder mixture under Ar atmosphere was selected for reasons of availability of material and facility of post-reaction processing. It was confirmed by chemical and x-ray analyses that UC was obtained at temperatures between 600 and 1,200°C. The purest UC was obtained at 900°C, and the conversion efficiency of uranium reached a maximum of about 80%. (NSA of Japan)

11503 MASS SPECTROMETRIC INVESTIGATION OF THE VAPORIZATION, THERMODYNAMICS, AND DISSOCIATION ENERGIES OF LaS, ScS, YS, ZrS, AND UO. Steiger, Ronald Paul. Iowa City, Ia., Univ. of Iowa, 1968. 91p.

Thesis.

The dissociation energies of lanthanum monosulfide, scandium monosulfide, yttrium monosulfide, zirconium monosulfide, and uranium monoxide were determined mass spectrometrically through the study of gaseous isomolecular exchange reactions at high temperatures. The equilibria studied were the following: $US(g) + Y(g) \rightarrow U(g) + YS(g)$, $US(g) + La(g) \rightarrow LaS(g) + U(g)$, $ScS(g) + Y(g) \rightarrow Sc(g) + YS(g)$, $ZrS(g) + Y(g) \rightarrow Zr(g) + YS(g)$, $YO(g) + U(g) \rightarrow Y(g) + UO(g)$. The equilibrium constants for the above equilibria were determined as a function of temperature by measuring the ion current intensities of the gaseous species as they effused from a Knudsen cell, which contained a mixture of two metal sulfides or a mixture of a pure metal and another metal sulfide or oxide. The effusion studies were made in the temperature range 2000 to 2500°K by means of a modified time-of-flight mass spectrometer. The effusion cell, of single-crystal tungsten, was heated by electron bombardment with temperatures controlled to within ±2°C. Temperatures were measured by a calibrated optical pyrometer, sighted directly into the orifice through a shuttered window. The dissociation energies were calculated by both second and third-law methods. The heat of formation of LaS(s) was calculated from the "best" value for the dissociation energy of LaS(g), the heat of formation of S(g), the heat of sublimation of La, and a second-law value for the heat of sublimation of LaS. The result is $\Delta H^0_{f,298}(LaS,s) = -108 \pm 4$ kcal/mole. Phase studies on the zirconium-sulfur system indicated a ZrS phase, which had a NaCl type cubic structure with cell dimensions, 5.1522 ± 0.0005A. Solid solutions of ZrS and YS were prepared by vacuum annealing $ZrS_{1.6}$ with YS and Zr metal with YS. These solid solutions also exhibited a NaCl type structure. Mass spectrometric studies of zirconium sulfide showed that the vapor species present at high temperatures were Zr^+, ZrO^+, ZrS^+, S^+, and the sulfur polymers S_2^+ through S_8^+. Only a small amount of ZrO^+ was present and it disappeared after a short period of time. The sulfur polymers appeared to have been formed by combination of the sulfur on the Knudsen cell heat shields. (Disser. Abstr.)

11504 CHEMICAL ANOMALIES OF ACTINIUM. Haissinsky, M. (Laboratoire Curie, Paris); Gratot, I.; Beydon, J. J. Inorg. Nucl. Chem., 31: 341-8(Feb. 1969). (In French).

Artificially produced actinium is placed between Nd and Sm in the fractional crystallization order of the double nitrates of the rare earths with magnesium. The longstanding anomaly known for naturally occurring actinium was thus confirmed. In anion exchange of the rare earths, actinium is eluted by $LiNO_3$ together with neodymium. (auth) (UK)

11505 SPECIFIC ACTIVITY OF TECHNETIUM, RHENIUM, RUTHENIUM, PLATINUM, AND PALLADIUM IN CATALYTIC REACTIONS OF BENZENE WITH HYDROGEN. Kubicka, Helena (Inst. of Low Temperatures and Structural Research, Wroclaw). J. Catal., 12: 223-37(Nov. 1968).

The specific activities of technetium, rhenium, ruthenium, platinum, and palladium catalysts supported on silica and γ-alumina at a concentration of 1% were studied for the reactions of benzene with hydrogen in the temperature range of 100 to 235°C by the microreactor chromatographic pulse method. The surface areas of the metals were determined by selective hydrogen chemisorption at 20°C and by x-ray line-broadening methods. Measurements on ruthenium, platinum, and rhenium powders of known surface areas were applied to determine the metal site areas effectively occupied by one hydrogen atom. Both technetium and rhenium revealed a catalytic activity in hydrogenation of benzene to cyclohexane. At sufficiently high temperatures, both metals, like ruthenium, are also catalysts in benzene hydrogenolysis, resulting in aliphatic C_1-C_6 hydrocarbons. The specific activities of metals for hydrogenation and hydrogenolysis decrease in the order: $Ru > Pt > Tc \approx Pd > Re$ and $Ru > Tc > Re$, respectively. The apparent activation energies are 7 to 11 kcal/mole for hydrogenation and 29 to 32 kcal/mole for hydrogenolysis. Rhenium, ruthenium, platinum, and palladium supported on γ-alumina were found to be less active as compared with the same metals on silica carrier, but the maximum difference was only a nearly twofold change in specific activity. The activity and selectivity of technetium appear to be distinctly dependent on the nature of the support. The factors determining the catalytic activities of the metals are considered, e.g., the extent and strength of hydrogen adsorption, the mode of bonding of the benzene molecules, and the role of the carrier (auth)

11506 OSMOTIC AND ACTIVITY COEFFICIENTS OF TETRAALKYLAMMONIUM SALTS IN H_2O, D_2O, AND AQUEOUS UREA SOLUTIONS. A STUDY OF SOLVENT STRUCTURAL EFFECT ON PROPERTIES OF LARGE IONS. Chen, Chun-meei Lee. Worcester, Mass., Clark Univ., 1968. 113p.

Thesis.

Osmotic and activity coefficients of tetraalkylammonium fluorides and bromides in H_2O and in D_2O at 25° were determined by the isopiestic method for a concentration range of 0.1 to several molal. The mean molal activity coefficients, $\gamma_\pm$, of the fluorides were found to be strikingly high and in the increasing order: $Me_4NF < Et_4NF < Pr_4NF < Bu_4NF$. The $\gamma_\pm$ of Bu_4NF are, in fact, higher than those of any 1-1 electrolytes reported in the literature in the same concentration range at 25° ($\gamma_\pm = 3.60$ at m = 1.6). The $\gamma_\pm$ values of Bu_4NF in D_2O were found to be slightly higher than that in H_2O, while that of Me_4NF, Me_4NBr, and Bu_4NBr are slightly lower in D_2O solution. Water structure influences seem to play a significant role in determining the activity coefficients of the tetraalkylammonium salts in aqueous solutions. The large values of $\gamma_\pm$ for the fluorides were attributed to the structural repulsion or "structural salting out" of the cation and the anion against each other arising from the fact that the cation and the anion are structure-making in incompatible modes and therefore, with increasing concentration, compete against each other increasingly to influence the structure of water in different ways. Since D_2O has more structure than H_2O, the "structural salting out" effect would be expected to be greater in D_2O solution in agreement with the observation of higher $\gamma_\pm$ values for Bu_4NF in D_2O than in H_2O.

The lower $\gamma_\pm$ values in D_2O than in H_2O for Me_4NF, Me_4NBr, and Bu_4NBr are explained in terms of the structural salting-in effect. Osomotic and activity coefficients of $Na_2B_{12}H_{12}$ and $(NH_4)_2B_{10}H_{10}$ were measured the the results are discussed in terms of the structural salting effect. Activity coefficients for two ternary systems, water–urea–Me_4NBr and water–urea–Bu_4NBr at 25° were also determined by the isopiestic method. A method similar to that employed by Bower and Robinson was used for evaluating activity coefficients in the mixed solution from the results of the isopiestic measurements. The equations for the activity coefficients of urea, γ_1, and of R_4NBr, γ_2, in the ternary solution containing urea and R_4NBr with molalities m_1 and m_2, respectively, are given. Equations are also given for Me_4NBr and Bu_4NBr in urea and water. It was found that in the concentration range studied ($m_{urea} \leq 5$, $m_{Bu_4NBr} \leq 6$ for system water–urea–Bu_4NBr and $m_{urea} \leq 15$, $m_{Me_4NBr} \leq 6$ for system water–urea–Me_4NBr), each solute component is "salted in" by the other as evidenced by the lowering of the activity coefficient in the presence of the other solute. The "salting-in" effect was found to increase with the cationic size of the tetraalkylammonium salt. The lowering of activity coefficients of urea and R_4NBr is believed to be caused by the formation of some complex-like aggregate among R_4NBr, urea, and water in aqueous solution. Free energy of transfer of tetraalkylammonium bromides from water to urea solution has been calculated. The results indicate that the transfer can proceed spontaneously from water to urea solution. (Disser. Abstr.)

11507 SINGLE CRYSTAL X-RAY DIFFRACTION STUDY OF H_2O, D_2O, $H_2{}^{18}O$ AND $D_2{}^{18}O$ HEXAGONAL ICE. **Handler, Erika St. Brooklyn, Polytechnic Inst. of Brooklyn, 1968. 108p.**

Thesis.

Research was undertaken in order to determine the effects of substituting D for H and ^{18}O for O on the interatomic distances and angles, on the atomic temperature factors and on the thermal expansion of ice. The hexagonal form of H_2O, D_2O, $H_2{}^{18}O$, and $D_2{}^{18}O$ single crystals were studied by x-ray diffraction methods. Integrated intensity measurements were made on single crystals on the four isotopes at –50 and –150°C using a counter Weissenberg diffractometer. The atomic coordinates and temperature factors were refined by the method of least squares. The centrosymmetric Pauling model of the ice structure was found to best describe the structure. The results of the refinement, based on the Pauling model, indicate only minor variations between the four isotopic forms. The lattice constants of the four isotopic ices were measured between –10 and –170°C using a single crystal diffractometer. The substitution of D for H causes an expansion of the lattice at all temperatures. The effect of substituting ^{18}O for O was less clear and appears to be temperature dependent. The coefficient of thermal expansion shows the normal behavior of decreasing as the temperature is lowered. The c/a ratio of all the ices is constant with temperature and significantly less than 1.6333, the ideal value for hexagonal close packing. (Disser. Abstr.)

11508 VIBRATIONAL ANALYSIS OF COPPER CHLORIDE DIHYDRATE. **Fifer, R. A.; Schiffer, J. (Temple Univ., Philadelphia). J. Chem. Phys., 50: 21-5(Jan. 1, 1969).**

Room- and low-temperature infrared spectra of copper chloride dihydrate and its deutero modifications were obtained, as well as polarized spectra of oriented polycrystalline films of the hydrate. Bands due to vibrations of H_2O, D_2O, and HOD molecules in the hydrate, as well as their polarization, are considered in terms of the crystal structure and previous interpretations of the vibrational bands of the solid. (auth)

11509 ACTIVATED AROMATIC SUBSTITUTION BY PIPERIDINE OR [1-^{2}H]PIPERIDINE IN BENZENE. DEPENDENCE OF KINETIC DEUTERIUM ISOTOPE EFFECT ON THE GROUP DISPLACED. **Pietra, Francesco; Vitali, Dairo; Frediani, Sergio (Univ., Pisa, Italy). J. Chem. Soc., B, No. 12, 1595-1600(1968).**

Rates of reactions of 1-chloro-4,7-dinitronaphthalene (A), 4-chloro-3-nitrobenzotrifluoride (B,B′), 2,4-dinitrophenyl cyclohexyl ether (C), 1-fluoro-4-nitrobenzene (D), or 1-fluoro-4,7-dinitronaphthalene (E) with piperidine or [1-^{2}H]piperidine to form exclusively N-4,7-dinitronaphthyl- (A,E), N-2-nitro-4-trifluoromethylphenyl- (B,B′), N-2,4-dinitrophenyl- (C), or N-4-nitrophenyl-piperidine (D) were measured as a function of nucleophile concentration in benzene. Both the extent of rate acceleration by piperidine and the value of the kinetic deuterium isotope effect vary with the leaving group. When the leaving group is chloride, contrary to a previous report, the reactions were found to be only very mildly accelerated, and in a linear fashion, by piperidine. Moreover, substitution of deuteriated amine (90% deuteriated) for piperidine did not appreciably alter the kinetics. For cyclohexyloxy- (C) or fluoride (D,E), third-order kinetics (second-order in amine concentration) were obtained. The relative reactivity of the light amine over the deuteriated amine was 1.49 ± 0.03 for reaction C, 1.03 ± 0.04 for reaction E, and ca 1.1 for reaction D. These facts are interpreted within the framework of the intermediate complex mechanism with decay of the addition intermediate into products being fast in reactions A and B and slow in the other reactions. (auth) (UK)

11510 ULTRA-VIOLET DIFFUSE REFLECTANCE SPECTRA OF THE HYDRATED OXIDES OF PROTACTINIUM(V) AND OF NIOBIUM(V) AND SOME RELATED COMPOUNDS. **Miranda, C.; Muxart, R.; Stchouzkov, T.; Vernois, J. (Institut de Physique Nucleaire, Val-de-Marne, France). J. Inorg. Nucl. Chem., 30: 2959-69(Nov. 1968).**

Protactinium(V) and niobium(V) hydrated oxides show single absorption bands at 260 and 268 nm, respectively The anhydrous oxides show additional lower energy bands whose relative intensities depend on their crystalline structures. The 260 and 268 nm bands are attributed to the M–O–M bonds in a disordered environment. Protactinium peroxide and protactinium oxalate, hydrolytic compounds where the "hydrated oxide structure" is likely to be preserved, have spectra resembling that of the hydrated oxide. The true complex potassium oxotrioxalatoniobate(V), however, has an absorption spectrum bearing little resemblence to that of the hydrated niobium oxide. The assignment of the 260 nm band to the Pa–O–Pa bonds may thus account for the absorption in the 240 to 300 nm region which is generally associated with the hydrolysis of Pa(V) in several aqueous media. (auth)

11511 ACID-CATALYZED REACTIONS OF EXO- AND ENDO-BICYCLO [3.2.1] OCT-3-EN-2-OLS. **Vlazny, James Charles. Madison, Wis., Univ. of Wisconsin, 1968. 128p.**

Thesis.

The acid-catalyzed isomeric rearrangements of exo- (1a) and endo- (2a) bicyclo[3.2.1]oct-3-en-2-ols in aqueous acetone result in interconversion of enantiomers (racemization) and geometric isomers (isomerization). Kinetic studies were made on the loss of optical activity (k_α), isomeric equilibration, (k_{eq}) and oxygen-18 exchange (k_{exc}) for each isomer. From the isomeric equilibration data and the value of the equilibrium constant (2a/1a) the rate constants for isomerication ($k_{i,exo}$ and $k_{i,endo}$) were calculated. For the exo isomer, 1a, the rate of loss of optical activity was ca seven hundred times that of isomerization. For the endo isomer, 2a, the rate of loss of optical activity and the rate of isomerication were indistinguishable. The kinetic data show that the conjugate acids of both isomers ionize to a common carbonium ion intermediate. Energies of activation were determined from the temperature dependence of the rate constants and an energy diagram connecting the two isomeric alcohols with the carbonium ion intermediate was constructed. The value of the energy difference ($\Delta\Delta E$) between the transition states leading from this intermediate to the alcohols was 4.5 ± 0.5 kcal/mole, with the exo- alcohol transition state having the lower energy. The reactivity ratios ($k_{\alpha,exo}/k_{\alpha,endo}$) for the two isomers ranged from 260 at 19.90°C to 140 at 49.03°C. The partition ratios for exo and endo solvent capture of the bicyclo[3.2.1]oct-3-en-2-yl carbonium ion at these two temperatures was 904 and 450, respectively. The energy difference between the two transition states is explained in terms of steric and stereoelectronic effects. Experiments with ^{18}O-labeled alcohols showed that with the endo isomer, 2a, the rate of ^{18}O-exchange is indistinguishable from the rate of loss of optical activity. With the exo isomer, 1a, exchange was slower than loss of optical activity (the k_{exc}/k_α ratio was ca 0.6). The exchange results were interpreted in terms of conformational considerations. (Diss. Abstr.)

11512 APPLICATIONS OF RADIOISOTOPES IN POLAROGRAPHY. **Wildman, Emil. Bloomington, Ind., Indiana Univ., 1968. 123p.**

Thesis.

A procedure has been devised whereby accurate radioactivity-voltage curves may be obtained from a solution containing a radioactive isotope of an ion that reduces to an amalgam. The radioactivity appearing in the amalgam parallels the polarographic current. If sufficient precautions are taken, the shape of the radioactivity vs voltage curve corresponds to theory, i.e., a plot of $\log(\bar{a}_d - a)/a$ versus E_{de} ($\underline{a}$ being radioactivity) is linear with a slope of RT/nF. The method was tested with reversibly reduced thallous ion containing thallium-204, a beta emitter. So called "radiopolarograms" were also obtained using several other isotopes. The presence of carbon tetrachloride, used by Love (Anal. Chim. Acta, 18, 72 (1958)) in similar experiments to allow the collected mercury to be separated from the radioactive solution, was found to produce erratic results. Accordingly, a convenient cell was designed which eliminates the need for a heavy organic solvent by utilizing "locks" to isolate the radioactive solution. The cell also has provision for automatic, counter-current washing of the mercury amalgam. The drops are collected for measured periods of time at a series of voltages. The mercury is evaporated from steel planchets before the radioactivity is counted. The experiments utilizing Tl-204, which was not carrier-free, were carried out at total concentrations of thallium ranging from 10^{-4} to 10^{-8}M. At the lower concentrations, the diffusion region of the curve was not flat, but rose sharply with increasingly negative applied potential. This rise was eliminated by addition of excess inactive thallium or other more easily reducible ions, such as Cu(II). These experiments indicate that the capacitive charge on the mercury drops, which increases past the electrocapillary maximum, is being removed by faradaic processes such as the reduction of thallium or copper as the drops fall through the solution. Only when the total concentration of the reducible ions is very low and the specific activity of the radioisotope is high does the relative effect of capacitive charge become important. A quantitative experiment to test the relation between diffusion limited activity and the concentration of Tl-204 in the presence of Cu(II) was carried out. The "diffusion activity constant" (analogous to conventional diffusion current constant) for Tl-204 was found to be 3,660 counts per minute for a 100 second collection from 1.0 micromolar solution. Lingane's observation that the heights of the polarographic waves due to the reduction of cadmium ion and the reduction of iodate ion are not additive when the two are present together in solution was studied using cadmium-115m tracer. The radiopolarogram of this mixture confirmed Lingane's explanation that the loss of current additivity arose from the precipitation of cadmium as $Cd(OH)_2$ in the vicinity of the dropping electrode by hydroxide ion produced as a reduction product of iodate ion. A radiopolarogram of copper-64 showed only one wave instead of the conventional doublet wave. This is because the first reduction is from Cu(II) to cuprous ion and does not form amalgam. The second wave, corresponding to reduction to copper amalgam, occurs at the known half-wave potential for this reaction. Radiopolarograms of indium-114 and manganese-56 were obtained and also showed half-wave potentials in good agreement with literature values. (Diss. Abstr.)

11513 STRUCTURE OF THE ALKALI HYDROXIDES. III. MICROWAVE SPECTRA OF RbOH AND RbOD. Matsumura, Chi; Lide, David R. Jr. (National Bureau of Standards, Washington, D. C). J. Chem. Phys., 50: 71-5(Jan. 1, 1969).

The microwave spectra of gaseous RbOH and RbOD were measured with a high-temperature spectrometer. The spectra are generally similar to those observed in CsOH and indicate an essentially linear structure for rubidium hydroxide. The variation of rotational constant with excitation of the bending mode shows anomalies similar to those found in CsOH. The Rb—O bond length is found to be 2.30_5 Å, while the O—H distance is 0.96_5 Å. Analysis of the nuclear quadrupole hyperfine structure gives eqQ values of −67.9 Mc/sec in ^{85}RbOH and −35 Mc/sec in ^{87}RbOH. (auth)

11514 VIBRATIONAL SPECTRA AND STRUCTURE OF ORGANOPHOSPHORUS COMPOUNDS. VI. INFRARED AND RAMAN SPECTRA OF CH_3OPSF_2 AND CD_3OPSF_2. Durig, James R.; Clark, James W. (Univ. of South Carolina, Columbia). J. Chem. Phys., 50: 107-19(Jan. 1, 1969).

The infrared spectra of both CH_3OPSF_2 and CD_3OPSF_2 in the vapor phase were recorded from 4000 to 33 cm^{-1}. Carbon disulfide solution spectra were also investigated to 200 cm^{-1}. The Raman spectra of the liquids and solids were recorded and depolarization values measured. At least two isomeric configurations are indicated from the low-temperature Raman spectra, and from the lack of the variation of band intensity, it is concluded they have nearly equal energy. Only one torsional vibration was observed at 192 cm^{-1}, and it is concluded that it is composed of the CH_3 and P—O—C torsional vibrations and possibly mixed with other low-frequency skeletal modes. The doublet due to the P=S stretching vibration has a separation of only 31 cm^{-1}, whereas 100 to 150 cm^{-1} has been proposed as the separation for this normal mode in this type of compound. The other fundamental vibrations are assigned based on band positions, depolarization values, and isotopic shifts. The assignments are also compared to those previously given for the CH_3OPCl_2 and CH_3OPSCl_2 molecules. (auth)

11515 DENSITOMETRIC MEASUREMENT OF THE VIBRATIONAL RELAXATION OF HCl AND DCl IN SHOCK WAVES. Breshears, W. D.; Bird, P. F. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 50: 333-6(Jan. 1, 1969).

The vibrational relaxation of HCl and DCl was studied behind incident shock waves in the temperature range 700 to 2100°K. Relaxation was followed by time-resolved measurement of the post-shock density gradient using a laser-beam-deflection technique. Hydrogen chloride is found to relax more rapidly than DCl. The relaxation times obtained at temperatures above 1000°K are summarized by the expressions $(P\tau)_{HCl} = (4.21 \pm 0.14) \times 10^{-7} \exp[(64.0 \pm 5.7)(T^{-1/3} - 0.090)]$ atm · sec (1000 to 2000°K), and $(P\tau)_{DCl} = (7.41 \pm 0.09) \times 10^{-7} \exp[(77.7 \pm 2.1)(T^{-1/3} - 0.090]$ atm · sec (1000 to 2100°K). The values depart from Landau–Teller behavior at lower temperatures. These results are in serious disagreement with those of Borrell and with predictions of the SSH theory. However, they are in good agreement with the theory of Moore, suggesting that rotation–vibration energy transfer is important in the relaxation of HCl and DCl. Possible effects of strong dipole interactions are also discussed. (auth)

11516 PERMEATION, DIFFUSION, AND SOLUBILITY OF DEUTERIUM IN PYREX GLASS. Laska, H. M.; Doremus, R. H.; Jorgensen, P. J. (General Electric Research and Development Center, Schenectady, N. Y.). J. Chem. Phys., 50: 135-7(Jan. 1, 1969).

The permeation of deuterium through thin Pyrex bulbs was measured with a mass spectrometer. The activation energies and absolute values at 200°C for permeation and diffusion were nearly the same as for deuterium in fused silica. The solubility of deuterium in Pyrex was independent of temperature, and about the same as the solubilities of several gases in fused silica. These results are consistent with a free-volume theory of gas solubility in glass and the separation of Pyrex into silica and sodium borosilicate phases. (auth)

11517 INTERNAL ROTATION AND VIBRATION IN CH_2: = CCl—CH_2D. Meyer, R.; Guenthard, Hs. H. (Swiss Federal Inst. of Tech., Zurich). J. Chem. Phys., 50: 353-65(Jan. 1, 1969).

The infrared spectrum of $CH_2 = CCl-CH_2D$ in the region 4000 to 160 cm^{-1} is presented and assigned. From a comparison of the observed vibrational spectrum with normal-coordinate results based on the assumption of rotational isomers the methyl group is found to eclipse the double bond. A torsion–vibration calculation is set up and applied to the same molecule for comparison with the normal–coordinate results. Owing to the relatively high torsional barrier the vibrational fundamentals obtained from the two approaches differ by less than 1 cm^{-1}. The results suggest that for more precise treatments of vibrational spectra the dependence of the kinetic-energy matrix on all internal coordinates should be considered. (auth)

11518 ELECTROPHILIC SUBSTITUTION AT THE CARBON–BORON BOND. THE MECHANISM OF PROTODEBORONATION OF BENZYLBORONIC ACIDS. **Stiggall, Diana Lee. San Diego, Calif., Univ. of California, 1968. 249p.**

Thesis.

The base-catalyzed solvolysis (protodeboronation) of benzylboronic acid has been investigated with regard to kinetics, solvent effects, substituent effects, and solvent deuterium isotope effects at 80°C. The reactions in water, methanol, n-butanol, and 80% dioxane–water follow pseudo-first-order kinetics at a given base concentration, and there is virtually complete conversion to the boronate anion at pH's above 12 in water. A two-step process is consistent with the observed kinetics, i.e., a fast pre-equilibrium formation of boronate anion followed by slow cleavage of the boronate anion by water to form toluene and boric acid. The rate is slightly faster (1.3 times) in 80% dioxane–water which suggests dispersal of charge in the transition state. Possible mechanisms for the second step are S_E1, S_E2, and S_Ei. The latter was eliminated as an important possibility when it was found that the dimethyl ester of benzylboronic acid was cleaved only 10 times more slowly in dry methanol, in which a cyclic transition state is impossible, than in water under similar conditions of basicity and temperature. The reduction in rate can probably be attributed to the lower electrophilicity of methanol compared to water. Electron withdrawing substituents in the benzyl group (e.g., para-chloro) facilitate the cleavage and electron donating groups (e.g., para-methyl) retard it, a result which suggests that negative charge is developed on the benzylic carbon during the transition state. Solvent deuterium isotope effects were determined by a competition method and the product composition (RH/RD) was measured with a mass spectrometer at low ionizing voltage (~9 volts). The RH/RD determined in this way represents the primary isotope effect, k_H/k_D. Isotope effects were found for benzylboronic acid (1.35), p-methylbenzylboronic acid (1.33), p-fluorobenzylboronic acid (1.31), 1,2-diphenylethylboronic acid (1.49), and 2-t-butyl-1-phenylethylboronic acid (1.44). The k_H/k_D for the cleavage of benzyltrimethylsilane in basic aqueous methanol was found to be 1.18, a result which clearly shows that the leaving group has an effect on the relative rates of reaction of hydrogen and deuterium. This is to be expected for an S_E2 reaction in which bond breaking and making occur in the same step, but not in an S_E1 reaction in which the slow step is carbanion formation followed by a fast protonation step. The magnitude of the primary isotope effect is considered to be large enough to indicate an S_E2 reaction, but the substituent effects suggest that old C—B bond breaking is further along in the transition state than new C—H bond making. The reaction must therefore be between the extremes of limiting S_E2 and limiting S_E1. The kinetics in t-butyl alcohol containing sodium t-butoxide were not first order in boronic acid. This is discussed in terms of a possible disporportionation of the boronic acid to borinic acid which has been reported for phenylboronic acid. NMR techniques were used to determine the stereochemistry of the protodeboronations of 1,2-diphenylethylboronic acid and 2-t-butyl-1-phenylethylboronic acid. The former compound appears to go with predominant retention of configuration with no detectable inversion. The latter obviously goes by way of both inversion and retention pathways with some net retention apparent. (Diss. Abstr.)

11519 CARBON ^{13}C ISOTOPE EFFECTS IN THE DECARBOXYLATION OF ANTHRANILIC ACID. Zielinski, Mieczyslaw (Univ. of Warsaw. Univ. of Chicago). Rocz. Chem., 42: 1725-32(1968).

Carbon-13 and oxygen-18 isotope effects in the decarboxylation of initially free of solvent anthranilic acid were measured on the McKinney–Nier Mass Spectrometer. (auth)

11520 COMMENT ON PHYSICAL PROPERTIES OF FLUID CH_4 AND CD_4: THEORY. Bigeleisen, Jacob; Wolfsberg, Max (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 50: 561-2(Jan. 1, 1969).

Rebuttal is given to 2 papers published previously and abstracted in NSA as 22: 18765 and 18766. (P.C.H.)

11521 REPLY TO COMMENT ON PHYSICAL PROPERTIES OF FLUID CH_4 AND CD_4: THEORY. Steele, William A. (Pennsylvania State Univ., University Park). J. Chem. Phys., 50: 563(Jan. 1, 1969).

Rebuttal is given to a comment (see previous abstract) concerning 2 papers published previously and abstracted in NSA as 22: 18765 and 18766. (P.C.H.)

11522 EXTINCTION OF FLUORESCENCE IN URANYL SULFATE SOLUTIONS. Lucatu, Emanoil; Vasilache, Marilena (Institut de Physique, Bucharest). Compt. Rend., Ser. C, 267: 1668-70(Dec. 16, 1968). (In French).

Reversible extinction of the fluorescence produced by variation of the temperature of uranyl sulfate solutions was not caused by variation of the viscosity. Extinction of solutions of uranyl sulfate solutions by the addition of nonabsorbent substances (the anions Cl^-, Br^-, SCN^-, NO_3^-, alcohols, glycerol, acetone, phenols, and amines), because of the complexes formed, was not accompanied by the formation of nonfluorescent aggregates. (tr-auth)

11523 CHEMISTRY OF ACTINIUM. 1. STABILITY CONSTANTS OF CHLORIDE, BROMIDE, NITRATE, AND SULPHATE COMPLEXES. Shahani, C. J.; Mathew, K. A.; Rao, C. L.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay). Radiochim. Acta, 10: 165-7(Dec. 1968).

The complexes of actinium in chloride, bromide, nitrate, and sulfate solutions have been studied at $[H^+] = 1.0\underline{M}$ and $\mu = 1$ by a solvent extraction technique using the liquid cation exchanger dinonylnaphthalenesulfonic acid. The stability constants of the complexes $AcCl^{2+}$, $AcCl_2^+$, $AcBr^{2+}$, $AcBr_2^+$, $AcNO_3^{2+}$, $Ac(NO_3)_2^+$, $AcSO_4^+$, and $Ac(SO_4)_2^-$ are respectively 0.80 ± 0.09, 0.24 ± 0.08, 0.56 ± 0.07, 0.30 ± 0.06, 1.31 ± 0.12, 1.02 ± 0.12, 15.9 ± 1.3, and 71.1 ± 7.3. (auth)

11524 FAST REACTIONS AND PRIMARY PROCESSES IN CHEMICAL KINETICS. Proceedings of the Fifth Nobel Symposium, August 28–September 2, 1967, Soedergarn, Lidingoe, Sweden. Claesson, Stig (ed.). Stockholm, Almqvist and Wiksell, 1967. 487p. Sw. Crs. 135:-. (CONF-670844).

Twenty-seven papers dealing with fast reactions and primary processes in chemical kinetics were presented. Topics discussed were: absolute rate theory of elementary processes; fast reactions studied by kinetic spectroscopy; flash optical rotatory dispersion technique for excited state and primary process studies; direct measurements of reactions in the 10^{-1} to 10^{-8} second range by single and repetitive excitations with pulses of electromagnetic waves; quantum theory of dissipative systems and scattering processes; reaction of monoenergetic deuterium atoms with hydrogen molecules; flash photolysis and primary processes in the excited state; nonadiabatic energy transfer in gases; chemistry of the electron; interaction of low energy electrons with molecules; mechanisms for rate-determinating states in acid-base processes in liquid state; proton transfer and general acid-base catalysis; fast reactions of hydrogen and hydroxide ions; analysis of photosynthesis by pulse techniques in the 10^{-1}- to 10^{-8}-second range; applications of delayed fluorescence measurements; triplet-to-triplet energy transfer; kinetics of reaction control and information transfer in enzymes and nucleic acids; dissipative structures in chemical systems; mechanism of cis-trans isomerization at the carbon-nitrogen double bond; the physical chemistry of nerve action; mechanisms of electron-transfer reactions with excited molecules; resolution of individual steps during enzyme-substrate reactions; and, kinetics of electron transfer reactions in biological systems. (J.G.B.)

11525 ELECTROCHEMISTRY OF MOLTEN SALTS AND SOLID ELECTROLYTES. Baraboshkin, A. N. (ed.). Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial, No. 10, 1-124(1967). (In Russian).

Eighteen articles are included on molecular structure of molten electrolytic salts and the relation between the structure and physicochemical properties of the salts, such as density, viscosity, and surface ductility. The theory of diffusion potentials appearing on the boundary of two different salt melts is discussed. The solubility of Ti in molten magnesium chloride and melts containing zirconium and niobium chlorides was studied. Redox potentials for U(III) and U(IV) in chloride–fluoride melts were measured. (R.V.J.)

11526 MEASUREMENT OF THE MAGNETIC SUSCEPTIBILITY OF URANIUM(IV) IONS THAT ARISE BY HYDROLYSIS. Baran, V.; Votocek, O. (Institut fuer Kernforschung, Prague). Collect. Czech. Chem. Commun., 33: 4379-82(Dec. 1968). (In German).

The magnetic susceptibility of green precipitates formed in the hydrolysis of uranium(IV) salts was studied. Susceptibility of U^{4+} was calculated and results are given in tables. (M.C.G.)

11527 SYNTHESIS OF URANIUM SULFIDES FROM THE ELEMENTS. Komac, M.; Kolar, D.; Brcic, B. S. (Nuclear Inst. Jozef Stefan, Ljubljana, Yugoslavia). Vestn. Slov. Kem. Drus., 14-15: No. 1-4, 37-8(1967–1968).

A direct method for the preparation of uranium sulfides from the elements is described. Heating of uranium powder in the presence of sulfur vapors leads to the formation of mixture of uranium sulfides. After high-temperature homogenization the pure phases, US_2, U_3S_5, U_2S_3, and US were obtained. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 11443, 12287, 12978, and 13519.

11528 (AI-AEC-12721, pp 323-8) ADVANCED DEVELOPMENT, PHYSICAL RESEARCH. (Atomics International, Canoga Park, Calif.).

Research progress is reported on reactions of nitrous oxide with photoexcited molecules, photolysis of hydrocarbons, radiolysis and photolysis of tetrahydrofuran, reactions of hydrogen atoms with organic acids, and pulse radiolysis of naphthalene, biphenyl, and benzophenone. (M.C.G.)

11529 (BNWL-481-2, pp 127-53) RADIATION CHEMISTRY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

AGAROSE—radioinduced liquefaction of aqueous jellies of, protective effects of artificial food coloring dyes, flavin mononucleotide, and nitrous oxide against
ANILINE, DIETHYL-p-NITROSO-—radiation effects on oxidation of, in aqueous solutions, ESR spectral studies on comparison of ceric sulfate effects with
ANILINE, DIMETHYL-p-NITROSO-—radiation effects on oxidation of, in aqueous solutions, ESR spectral studies on comparison of ceric sulfate effects with
BENZENE, NITRO-—radiolysis of sodium hydroxide solutions of, ESR spectral studies on γ
BENZOIC ACID, p-AMINO-—radiation effects on oxidation of, in aqueous solutions, ESR spectral studies on comparison of ceric sulfate effects with
BENZOIC ACID, p-NITROSO-—radiolysis of sodium hydroxide solutions of, ESR spectral studies on γ
CERIUM SULFATES—effects on oxidation of aromatic nitroso-compounds in aqueous solutions, ESR spectral studies on comparison of radiation effects with
DYES—radiolysis of artificial food coloring triphenylmethane, in aqueous solutions, ESR spectral studies on
  —protective effects of artificial food coloring, against radioinduced liquefaction of agarose jellies
ELECTRONS—effects of pulsed, on alkaline, air saturated water, use of swept beams from 2-MeV Van de Graaff accelerator for studies on
FLAVIN MONONUCLEOTIDE—radiolysis in aqueous sodium sulfate and sucrose solutions, ESR spectral studies on radicals produced by γ

—protective effects against radioinduced liquefaction of agarose jellies
GAMMA RADIATION—effects on triphenylmethane dyes in aqueous solutions, ESR spectral studies on
—effects on nitrobenzene and p-nitrobenzoic acid in aqueous sodium hydroxide solutions, ESR spectral studies on
—effects on flavin mononucleotide in aqueous sodium sulfate and sucrose solutions, ESR spectral studies on radicals produced by
—effects on methylene blue in sodium sulfate, sucrose, and water, ESR spectral studies on radicals produced by
METHANE, TRIPHENYL—radiolysis of artificial food coloring dyes of, in aqueous solutions, ESR spectral studies on γ
—protective effects of artificial food coloring dyes of, against radioinduced liquefaction of agarose jellies
METHYLENE BLUE—radiolysis in sodium sulfate, sucrose, and water, ESR spectral studies on radicals produced by γ
NITROGEN OXIDES N_2O—protective effects against radioinduced liquefaction of agarose jellies
OZONIDES—decay kinetics of ionic, use of analog simulator program for studies on
PHENOL, p-NITROSO-—radiation effects on oxidation of, in aqueous solutions, ESR spectral studies on comparison of ceric sulfate effects with
RADIATION—effects on oxidation of aromatic nitroso-compounds in aqueous solutions, ESR spectral studies on comparison of ceric sulfate effects with
—effects of liquefaction of agarose jellies, protective effects of artificial food coloring dyes, flavin mononucleotide, and nitrous oxide against
RADIATION CHEMISTRY—mechanism of formation of long-lived transients in electron pulse radiolysis, use of swept beams from 2-MeV Van de Graaff accelerator for studies on
TRYPTOPHAN—radiation effects on oxidation of, in aqueous solutions, ESR spectral studies on comparison of ceric sulfate effects with
VAN DE GRAAFF ACCELERATORS—uses of swept beams from 2-MeV, in electron pulse radiolysis studies
WATER—radiolysis of alkaline, air saturated, use of swept beams from 2-MeV Van de Graaff accelerator in electron pulse (P.C.S.)

11530 (JINR-E7-4207) SYNTHESIS AND STUDY OF NEW ISOTOPES AND ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 11p. Dep.

The synthesis of new elements and, in particular, the problems of the synthesis of super-heavy elements in the range of nuclear atomic numbers from 110 up to 114 are discussed. (auth)

11531 (ORO-3519-3) RADIATION CHEMISTRY OF MONO-SUBSTITUTED AROMATIC COMPOUNDS. Progress Report, January 15, 1968–January 15, 1969. Knight, J. A. Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Jan. 27, 1969. Contract AT(40-1)-3519. 21p. Dep. CFSTI.

Studies were initiated on the radiation chemistry of monosubstituted benzenes with nonhydrocarbon substituents, ArX, and from the data obtained partial rate factors for the relative reactivities of the various positions in the mono-substituted benzenes in the generation of reactive species and in subsequent reactions by the reactive species with ArX were determined, if feasible. The first compounds to be studied were nitrobenzene, with an electron-attracting group, and aniline, with an electron-releasing group, with major emphasis on the radiolysis of nitrobenzene. Nitrobenzene was γ-irradiated at 30°C and 80°C and the major radiolytic products determined. Some irradiations at 30°C with DPPH were made. Relative reactivities for the radiolytic phenylation of nitrobenzene were obtained and compared with the free radical phenylation results. Data indicate that, in the radiolysis of nitrobenzene, processes other than phenylation of nitrobenzene by a phenyl free radical are also producing the isomeric nitrobiphenyls. Preliminary irradiations of aniline indicate that aniline is more radiation resistant than nitrobenzene. Hydrogen gas ($G \sim 0.11$) and three isomeric aminobiphenyls, 2,2′-diaminobiphenyl, and diphenylamine were identified as radiolytic products. (J.G.B.)

11532 NEUTRON ACTIVATION PRODUCTS FROM AROMATIC PHOSPHORUS COMPOUNDS. Wheeler, Owen; Santos, Milagros; Facetti, Juan F. (Puerto Rico Nuclear Center, Mayaguez). Radiochim. Acta, 10: 133-7(Dec. 1968).

The phosphorus-32 compounds formed in the thermal neutron activation of solid triphenylphosphine, triphenylphosphine oxide, and tetraphenylphosphonium chloride were investigated. It is suggested that the inorganic phosphorus acids result from the reaction with water of phosphorus cations trapped in the crystal, or of intermediates formed between these cations and oxygen, or chloride ion in the lattice. The organic phosphorus acids are probably formed by recombination with phenyl radicals. Retention was less than 3% in these compounds. (auth)

11533 FREE RADICALS IN IRRADIATED FATTY ACIDS. **Wozniak, Jan; Krauze, Stanislaw (Zaklad Badania Srodkow Spozywczych, Warsaw). Rocz. Panstw. Zakl. Hig., 19: 317-27 (1968). (In Polish).**

Linoleic and erucic acids were irradiated with a ^{60}Co source and the electron spin resonance spectra of the products recorded at various temperatures; the apparatus is described and illustrated. Temperature dependence of the ESR signals allowed the detection of fine structure in the generally broad absorption; data for irradiated samples between −170°C and −140°C are illustrated, and splitting constants derived for species estimated to be present. Mechanisms of radical formation are discussed; the role of hydroperoxides in these processes and those of autoxidation and initiation of chain reactions are suggested. Particular attention is drawn to the effect of Fe soaps and salts of other cations with variable valence in affording new routes for decomposition of hydroperoxides. (BBB)

11534 EFFECTS OF GAMMA RADIATION ON AQUEOUS SOLUTIONS OF 2′–3′ URIDYLIC ACID. Castro, Enrique; Jimenez, Rosa (Univ. Catolica de Chile, Santiago. Univ. de Chile, Santiago). Photochem. Photobiol., 7: 721-6(June 1968).

The free radicals induced by γ radiation in deaerated aqueous solutions of 2′- and 3′-uridylic acid at 77°K were studied by electron spin resonance techniques. The annealing at 193°K of the OH radical trapped at 77°K produces a secondary radical at the uridylic acid base. Saturated base products were detected chromatographically. A mechanism is proposed for the formation of these degradation products. (auth)

11535 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS AND ANNEALING IN INORGANIC CRYSTALS. Diefallah, El-Hussieny Mohamed Mohamed. Urbana, Ill., Univ. of Illinois, 1968. 173p.

Thesis.

The chemical effects of radiative neutron capture and associated radiation damage have been investigated for ^{191m}Os and ^{193}Os produced in pure crystals of $K_4Os(CN)_6$ and $Ca_2Os(CN)_6$, as well as in isomorphous mixed crystals of the type $K_4Os(CN)_6$–$K_4Fe(CN)_6$ and $Ca_2Os(CN)_6$–$Ca_2Fe(CN)_6$. The chemical effects of the isomeric transition ^{191m}Os (I.T.) ^{191}Os were studied in crystals of pure $K_4Os(CN)_6$. High voltage paper electrophoresis was utilized for separation and identification of the chemical entities incorporating the hot atom and formed after dissolution of the neutron-irradiated sample in 0.001 N HCl solution. Two osmium chemical states, OsO_2 and the parent $Os(CN)_6^{4-}$, were observed in this analysis. Individual retentions of ^{191m}Os and ^{193}Os were calculated from the experimental data obtained by assaying the radioactivity associated with the chemical species separated on the paper. The observed increase in cyanoösmate(II) retention with decreasing mole fraction of the parent in the mixed crystals was found to follow an exponential dependence. This type of dependence is compatible with data reported in the literature for other types of isomorphous mixed crystals studied. An electron acceptor-donor mechanism involving electron-hole traps and electron recombination centers has been proposed to explain the influence of isomorphous dilution on the probability of parent reformation. Although isomorphous dilution can cause large changes in parent retention, it does not have much effect on isotope separations. Observed isotopic separations are regarded as due primarily to differences in the charge states established on the two isotopes and to secondary consequences resulting from interactions with the chemical environment. In comparing chemical consequences of (n,) and isomeric transition processes, considerations are given to the kinetic energy of the recoil atom, charge states of recoil fragments, and the nature of the chemical environment. The thermal annealing of osmium nuclear recoils was investigated in crystals of pure cyanoösmate(II) and in mixed crystals of the type $K_4Os(CN)_6$–$K_4Fe(CN)_6$. Isomorphous dilution was found to influence the kinetics and activation energies of the annealing processes. The fast part of the annealing process takes place more rapidly in mixed than in pure cyanoösmate(II) crystals. A Fletcher-Brown treatment of annealing data showed that the composite annealing curve in pure and mixed crystals cannot be represented by a single rate process and that a combination of rate processes is more appropriate. Analysis of annealing curves according to the Vand-Primak method gave a spectrum of activation energies ranging from 0.5 to 1.0 eV between room temperature and 192°C, and with an arbitrary frequency factor $B = 10^5$ sec^{-1}. In mixed crystals the spectrum of activation energies is shifted to lower values. An electron acceptor-donor mechanism involving electron-hole traps and electron recombination centers also seems acceptable for explaining annealing reactions of recoil and radiation damage in pure and mixed crystals and for accounting for the differences observed between the two types of crystals. (Diss. Abstr.)

11536 METHOD FOR PRODUCING POLYETHYLENE TETRAFLUORIDE WITH HIGH THERMAL STABILITY. Fujioka, Shuji (to Toyo Rayon Co., Ltd.). Japanese Patent 1968-21314. Sept. 12, 1968. Filed Oct. 26, 1965.

To obtain polyethylene tetrafluoride with high thermal stability, less than 10% of the ethylene tetrafluoride is first polymerized with ionizing radiation. Then, the polymerized portion is separated from the portion not polymerized. The latter is polymerized with ionizing radiation. (NSA of Japan)

11537 INITIAL DISTRIBUTION OF ^{32}P-ACTIVITY IN NEUTRON IRRADIATED $NH_4H_2PO_4$. Fenger, J. (Oersted Inst., Copenhagen). Radiochim. Acta, 10: 138-41(Dec. 1968).

The fate of ^{32}P-recoils in ammonium-dihydrogen phosphate was investigated by paper electrophoresis. It is demonstrated that species containing probably 3 phosphorus atoms with ^{32}P in a reduced state are formed. More complex species represent at most about 1 percent of the ^{32}P-activity. (auth)

11538 THE FRANCESCO GIORDANI RADIATION CHEMISTRY AND NUCLEAR CHEMISTRY LABORATORY. Com. Naz. Energ. Nucl., Notiz., 14: No. 11, 88-98(Nov. 1968). (In Italian).

This Laboratory, established in 1960 for the purpose of conducting basic chemical research of nuclear interest, has concentrated its research activities on the study of the chemical effects of ionizing radiations, of photonuclear radiations, and of the chemical and chemico-physical properties of systems and compounds of major interest in nuclear technologies. (auth)

11539 THE GAMMA-RAY-INDUCED RADIOLYSIS OF PROPIONALDEHYDE IN THE LIQUID PHASE. Toelgyesi, M.; Marta, F. (Attila Jozsef Univ., Szeged). Acta Phys. Chem., 14: 27-38 (1968).

The γ-ray-induced decomposition of propionaldehyde was investigated, and products formed during the decomposition and their G values determined. To obtain more information about the role of the secondary processes of the radiolysis, the following factors were also investigated: changes in the G values of the products as a function of dose intensity, concentration of the initial substance, time of irradiation, and the inhibiting effect of iodine and nitric oxide. Between 2 and 21 × 10^{20} eV/g, G values of the main gaseous products are independent of doses and have the following values: total gas, 7.3; CO, 3; C_2H_6, 2.3; H_2, 1.7. For liquid products, isobutanol has a maximum G value of 0.6 at 7 × 10^{20} eV/g, decreasing to 0.2 at 20 × 10^{20} eV, while methyl ethyl ketone increases from 0.2 to 0.6 in the range 3 to 20 × 10^{20} eV/g. The changes in the G values of diethyl ketone and isoamyl alcohol show a similar curve to that obtained for methyl ethyl ketone; however, their G values are smaller by 1 and 2 orders of magnitude respectively. The G value for disappearance of starting material is 45 at 4 × 10^{20} eV/g, and is constant at 26 between 6 and 20 × 10^{20} eV/g. These are ~10-fold of what could be expected on the basis of the G values of the products. This enormous difference can possibly be attributed to the formation of polymers. The decomposition takes place according to a chain mechanism, where, in certain steps, free radicals are involved. With increasing doses, the role of the elementary steps involving free radicals becomes more important than that of the molecular steps. (BBB)

11540 INFLUENCE OF CHEMICAL AGENT ON THE RATE OF RADIOINDUCED POLYMERIZATION OF ACRYLAMIDE OF METHACRYLAMIDE AND SOME N-TERT-ALKYLACRYLAMIDES. II. EFFECTS OF INHIBITORS AND WATER. Swiderski, Jan; Zurakowska-Orszagh, Janina (Univ. of Warsaw). Rocz. Chem., 42: 1299-6(1968). (In Polish).

Investigations on the effects of hydroquinone addition and the presence of water on the rate of radioinduced solid-state polymerization of acrylamide, methacrylamide, and some N-tert-alkylacrylamides were carried out. (auth)

11541 HEAT SOURCE MATERIAL. (to Sanders Nuclear Corp.). British Patent 1,138,578. Jan. 1, 1969. Priority date Dec. 2, 1966, United States.

Thulium-171 for use in radioactive heat sources is produced by irradiating ^{169}Tm for a period of 10 days to 2 yr at a neutron flux in the range of 10^{14} to 10^{16} n/cm^2/sec to produce a mixture of ^{169}Tm, ^{170}Tm, ^{171}Tm, and Yb and subsequently permitting this mixture to decay for a selected time interval during which the ^{170}Tm decays at a more rapid rate than the ^{171}Tm to produce a resultant mixture having a higher ratio of ^{171}Tm to ^{170}Tm than was present immediately after irradiation. The Yb is separated from the resultant mixture by passing the mixture through an ion exchange media. (B.L.M.)

11542 BEAM STUDIES OF THE ENERGY DEPENDENCE OF HOT HYDROGEN REACTIONS. Menzinger, Michael Adolph. New Haven, Yale Univ., 1968. 216p.

Thesis.

In order to study the energy dependence of high-energy H atom reactions by means of beam methods monoenergetic tritium ion beams of variable energy and narrow energy spread were generated and allowed to strike a solid target, for which cyclohexane was chosen as a prototype. Labeled products were analyzed by gas chromatography in conjunction with internal flow-counting. A detailed description of the apparatus "ADAM" is given. The yields of labelled cyclohexane, n-hexane, and hexenes from the reactions of T_2^+ with solid cyclohexane, and the yield of cyclohexane from the reaction of T^+ with solid cyclohexane were determined as a function of the beam energy (1 to 200 eV). For a comparison with the beam results, a series of specially designed recoil experiments were performed, during which tritons, generated by the $^3He(n,p)^3H$ reaction, were allowed to strike a cyclohexane film, which was frozen onto the walls of the irradiation vessel. At triton energies above 50 to 100 eV, the cyclohexane-T yield (on a per-triton-basis) stemming from T^+ and from T_2^+ lies close to the corresponding recoil tritium yield. The reaction efficiency drops sharply below 10 eV and seems to level out below 1.5 eV. The shape of the yield functions is similar for initial T^+ and T_2^+ beams. It was concluded that prior to chemical incorporation into the target molecule, both T_2^+ and T^+ ions undergo charge transfer with cyclohexane to yield tritium atoms with high efficiency. The yield for T_2^+ is somewhat lower than for T^+, since not all of the ions are dissociated, and therefore are lost for reaction. The results may be interpreted in terms of Hot Atom Reactions while major contributions by ion-molecule reactions can be ruled out. The n-hexane and the hexene yields exhibit a sharp rise around 5 eV triton energy, corresponding to the threshold energies for the formation of these products. An approximate excitation function for the hydrogen substitution reaction is calculated. The "cross section" rises steeply from a threshold at about 1 eV to the vicinity of 10 eV, thus confirming estimates made in recoil chemistry. (Disser. Abstr.)

11543 RADIOLYSIS OF AQUEOUS SOLUTIONS OF POTASSIUM HYDROXYLAMINE DISULFONATE. Sharpatyi, V. A.; Zakatova, N. V. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 10, 2197-2203(Oct. 1968). (In Russian).

The radiolysis of aqueous solutions of potassium hydroxylamine disulfonate under different irradiation conditions (concentration, pH, introduction of additives, etc.) was studied by electron paramagnetic resonance. Results indicate the radiolytic oxidation of $HON(SO_3K)_2$ by OH radicals. The high yields are explained on the assumption that excited molecules of water participate in reactions of the radiolytic products. The system $HON(SO_3K)_2-H_2O$ can be used as an indicator for determining the reaction rate constant for the oxidizing component in the radiolysis of water with substances dissolved in it. (tr-auth)

11544 CHAIN FORMATION OF FORMALDEHYDE IN THE GAMMA RADIOLYSIS OF METHANOL IN THE PRESENCE OF HYDROXIDES AND THE LOWER OXIDES OF NITROGEN. Sibirskaya, G. K.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 10, 2377-9 (Oct. 1968). (In Russian).

The yield of formaldehyde from the γ radiolysis of methanol, which contained KOH and N_2O, was found to be 170 molecules/100 eV. Mechanisms for chain formation are postulated. (tr-auth)

11545 ABSENCE OF pH EFFECT ON THE SZILARD-CHALMERS REACTION IN POTASSIUM PERMANGANATE SOLUTION. Cogneau, M. A.; Apers, D. J.; Capron, P. C. (Univ., Louvain, Belg.). Radiochim. Acta, 10: 170-1(Dec. 1968).

Solutions of 0.01 M potassium permanganate at a representative pH value of 1, 7, and 13, respectively, were exposed for 2 min to a neutron flux of 8.5 × 10^{11} neutrons/cm^2/sec and a γ dose rate of 16.5 krads/min. It was confirmed that in strongly alkaline solutions Mn(II) appears in the permanganate fraction after formation of a soluble compound that is not adsorbed by alumina. It was concluded that the retention of potassium permanganate in solution is dependent of pH. The nonrecombined recoil Mn is totally recovered in the form of Mn(II). The results cannot be explained by a stripping of O^{2-} ions; the mechanism proposed involves the loss of O atoms, of O^- ions, or of both. (P.C.H.)

11546 ON A CORRELATION OF MOESSBAUER AND CHEMICAL DATA CONCERNING Fe^{+3} FORMATION BY NUCLEAR

REACTIONS. Fenger, J.; Siekierska, K. E. (Risoe Research Establishment, Roskilde, Denmark). Radiochim. Acta, 10: 172-3(Dec. 1968).

The chemical consequences of three processes, two, $^{56}Fe(n,\gamma)^{57}Fe$ and ^{57}Co(electron capture)^{57}Fe studied by Moessbauer spectroscopy and one, $^{58}Fe(n,\gamma)^{59}Fe$ studied radiochemically, were compared. Two ferrous systems ($FeSO_4 \cdot 7H_2O$ and $FeC_2O_4 \cdot 2H_2O$) were used. The results indicated that the (n,γ) process can also lead to oxidation. Up to room temperature the yield of $^{59}Fe^{3+}$ in neutron-irradiated oxalate was very near the yield of $^{57}Fe^{3+}$ in the oxalate sources (~10%). The yield of $^{59}Fe^{3+}$ found by radiochemical means in neutron-irradiated sulfate was so much smaller (3%) than that found by Moessbauer measurements on ^{57}Fe (40%) that the difference cannot be explained as an isotope effect. The results indicate that in oxalate the ferric ions survive long enough to be detected by chemical means. In sulfate, however, the initially high yield of Fe^{3+} found in the Moessbauer experiments was not observed when a chemical separation was performed. The different behaviors of the two systems might be due to the ability of oxalate to form complexes with Fe^{3+}. (P.C.H.)

11547 THERMAL DEGASSING UNDER VACUUM OF NUCLEAR GRAPHITE AFTER RADIOLYTIC OXIDATION. COMPARISON WITH THERMAL OXIDATION. Lang, F. M.; Blanchard, R.; Koch, C. (Commissariat a l'Energie Atomique, Saclay, France). Carbon, 6: 817-26(Dec. 1968). (In French).

Samples of graphite were irradiated in flowing CO_2 and in CO_2 containing small concentrations of CH_4 at 40 bars and 300°C. Variation of the CH_4 concentration produced either loss or gain in weight. On thermal degassing most of the species released were different from, and more stable than, those obtained following thermal oxidation. For samples showing a weight loss, the desorptive kinetics of the surface oxides were very similar to those observed without CH_4. On the other hand, the hydrogenated compounds gave two gas liberation peaks, the first of which appeared to be due to radiolysis products of CH_4. The amount of H_2 desorbed was not a function of the weight loss of the graphite. For samples irradiated in CO_2 and CH_4 and showing a weight gain, the total liberation increased with the weight increase of the graphite. In the presence of CH_4 the species from which the released gases derived were formed mainly in the peripheral layers of the graphite sample. (UK)

11548 CONCERNING THE THERMAL PROPERTIES OF RADICALS FORMED ON RADIOLYSIS OF CHILLED AQUEOUS SOLUTIONS OF DEOXYRIBONUCLEIC ACID (DNA). Bel'kovich, T. M.; Nadzhimiddinova, M. T.; Sharpatyi, V. A. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 2652-5(Nov. 1968). (In Russian).

During radiolysis of solutions of DNA the radicals are characterized by the temperature of their field of existence. The process of radical recombination in the system studied was complex. This is shown by the calculated kinetic parameters of the reactions, which change with annealing temperature. Kinetic measurements on irradiated solutions of DNA and 2-deoxyribose revealed the differences in the behavior of the radicals in relation to dissolved substances (the carbohydrate parts of the DNA and 2-deoxyribose in the free state), which is ascribed to the structural peculiarities of the bipolymeric molecule. (tr-auth)

11549 STERIC DISTRIBUTION OF RADICALS IN GAMMA-IRRADIATED CHILLED AQUEOUS SOLUTIONS. Ershov, B. G.; Chernova, G. P.; Grinberg, O. Ya.; Lebedev, Ya. S. (Inst. of Physical Chemistry, Moscow. Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 11, 2439-43(Nov. 1968). (In Russian).

The steric distribution of radicals in aqueous solutions of bases, acids, and salts, which were gamma-irradiated at 77°K, was studied. Electrons in solutions of bases and H atoms in solutions of salts were captured unevenly, and the steric distribution of H atoms in solutions of acids had an even character. (tr-auth)

11550 RADIOACTIVE THERMAL SOURCES. (to Sanders Nuclear Corp.). British Patent 1,138,577. Jan. 1, 1969. Priority date Dec. 2, 1966, United States.

A radioactive thermal source is produced by irradiating a target for a predetermined time at a preselected neutron flux to obtain a required initial power ratio of isotopes in a mixture having a predetermined half power life intermediate of any of the individual isotopes. Such a source is produced by irradiating ^{169}Tm to produce a mixture of ^{170}Tm and ^{171}Tm. (B.L.M.)

11551 ON THE INFLUENCE OF SOME DILUENTS ON THE REACTIONS OF RECOIL ARSENIC WITH BENZENE. Sokolowska, A.; Siuda, A. (Inst. of Nuclear Research, Warsaw). Radiochim. Acta, 10: 107-8(1968).

The dependence of the yield of phenylarsonic acid on the concentration of benzene was studied in the liquid two-component mixtures of $AsCl_3$–benzene and in the three-component systems of $AsCl_3$–benzene–nitromethane and $AsCl_3$–benzene–carbon tetrachloride. After irradiation, the ^{76}As products were separated by high-voltage paper electrophoresis. An evident correlation was noted between the yields of products and the relative values of the ionization potentials of the diluents and of the recoil atoms. This can be explained by the fact that, depending on the properties of a medium, ionized or perhaps excited, recoil As is involved in the formation of the products. (B.L.M.)

11552 THE RADIATION-INDUCED DECOMPOSITION OF KNO_3 CRYSTALS. Pogge, Hans Bernhard. Hoboken, N. J., Stevens Inst. of Tech., 1968. 166p.

Thesis.

Data are presented on chemical doping and isotopic (^{18}O) distribution studies of irradiated solid KNO_3 to substantiate the following proposition: At least two modes of decomposition are operative in irradiated KNO_3. One decomposition reaction forms O_2 by a direct molecular dissociation of nitrate radicals: $NO_3 \rightarrow NO + O_2$. The other mode apparently involves atomic O as an intermediate step, but the exact nature of this mechanism could not be unequivocally established. Doping experiments with KNO_2 revealed that the O formation becomes insensitive to nitrite at higher concentrations. Further support for two decomposition modes was sought by way of isotopic O studies. Theoretical considerations predict different isotopic O distributions. The experimental data do not correlate with the theoretical calculations when considering either one of the modes individually, but they do show good agreement when a combination of the two is considered. The mechanisms also correlate with previously reported data. (Disser. Abstr.)(TSS)

11553 CHEMICAL AND MOESSBAUER STUDY OF THERMAL NEUTRON CAPTURE IN MAGNESIUM STANNATE. Andersen, T.; Oestergaard, P. (Univ. of Aarhus, Denmark. Technical Univ. of Denmark). Trans. Faraday Soc., 64: 3014-20(Nov. 1968).

The chemical effects following thermal neutron capture in magnesium stannate were investigated using chemical analysis and Moessbauer measurements. The chemical analyses indicated only the presence of radioactive stannate after irradiation at 30 or 100°C, whereas the Moessbauer data showed the presence of different types of recoil products. The recoil products underwent a thermal annealing reaction between 150 and 500°C not involving Sn(II) recoil fragments, whereas thermal annealing above 550°C also transformed the Sn(II) recoil fragments to Sn(IV) fragments. Dilution of magnesium stannate with magnesium titanate had a marked effect on the formation of recoil products and on the thermal annealing reactions. Polymeric Sn(IV) recoil fragments were formed in the mixed crystals. These fragments could be detected by chemical analysis but not by the Moessbauer technique. (auth) (UK)

11554 KINETICS OF THE GAMMA RADIOLYTIC DECOMPOSITION OF AQUEOUS CYSTEINE SOLUTIONS. Al-Thannon, Adnan Abdel-Majeed. Newark, Del., Univ. of Delaware, 1968. 147p.

Thesis.

In order to elucidate the interaction of cysteine with various reactive intermediates arising from irradiated H_2O, the effects of cysteine concentrations, pH of the solution, added O_2, and that of other added specific radical scavengers on the radiolytic products were investigated. The major primary radiation decomposition products of aqueous cysteine (RSH) solutions exposed to doses varying from 3.8×10^{16} up to 6×10^{17} eV/g were found to be: H_2, H_2S, cystine (RSSR), H_2O_2, and alanine (RH). In air-free acid solutions at pH 1 a satisfactory S balance and overall material balance were achieved between the radiolytic product yields. With pH value and concentration varied over a wide range it was found that the H_2 yield always predominated over that of the H_2S at high concentrations of H^+ or relatively low cysteine concentrations, while H_2S predominated at high concentrations of cysteine or low concentrations of (H^+) ions. The results of studies at high cysteine concentrations and under various radiation intensities in air-saturated acidic solutions indicated that a chain reaction takes place in this system. In air-free, acidic, low concentration cysteine solutions, unexpected results were obtained. Further treatment of the water by preirradiation was not enough to explain the lower yields of the products found. (Disser. Abstr.) (TSS)

11555 RADIOACTIVE THERMAL POWER SOURCE WITH INTEGRAL MODERATOR. (to Sanders Nuclear Corp.). British Patent 1,138,579. Jan. 1, 1969. Priority date Apr. 5, 1967, United States.

A radioactive thermal power source is made up of layers of a radioisotope positioned next to layers of moderator material. The radioisotope is Tm, Co, in metal or oxide form; and the moderator material is carbon or graphite. Alternately, the radioisotope material may be mixed with the moderator material and extruded in any desired shape. (B.L.M.)

11556 MOESSBAUER EFFECT INVESTIGATIONS ON γ-IRRADIATED IRON COMPLEXES. I. OCTAHEDRAL "HIGH SPIN" COMPLEXES. Guetlich, Ph.; Odar, S.; Fitzsimmons, B. W.; Erickson, N. E. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 10: 147-53(Dec. 1968). (In German).

The High Spin complexes $FeSO_4 \cdot 7\ H_2O$, $(NH_4)_2Fe(SO_4)_2 \cdot 6\ H_2O$, $NH_4FE(SO_4)_2 \cdot xH_2O$ ($x \approx 1.5\ H_2O$) and $Fe(II)Ox \cdot 2\ H_2O$ were γ-irradiated (^{60}Co source) under vacuum at room temperature. The samples were analyzed by means of Moessbauer spectroscopy. It was found that $FeSO_4 \cdot 7\ H_2O$ and $(NH_4)_2Fe(SO_4)_2 \cdot 6\ H_2O$ are oxidized to basic ferric sulfate under the influence of γ-radiation, whereas for $NH_4Fe(SO_4)_2 \cdot x\ H_2O$ and $Fe(II)Ox \cdot 2\ H_2O$ no chemical change was observed. It is assumed that the ligands play an important role in the mechanism of the γ-induced reactions. As a primary step the radiolytic decomposition of the ligands into oxidizing and reducing products is suggested. The Moessbauer spectra of all irradiated compounds reflect a considerable radiation damage of the crystal lattice. (auth)

11557 THE CO_2/CO RATIO AS INTERNAL RADIATION DOSIMETER IN RECOIL CARBON ATOM STUDIES. Elias, H.; Wolf, A. P. (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta, 10: 111-12(1968).

The formation of CO and CO_2 was studied in the systems $C_2H_4-O_2$, CH_4-Co-O_2, $C_3H_8-O_2$, $C_3H_8-Co-O_2$, and $CO-O_2-N_2$ as a function of γ dose by irradiation of the gas mixtures at 30°C and a total pressure of 600 mm Hg with γ rays from a ^{60}Co source. The products were analyzed by gas chromatography. G values for CO_2, CO, O_2, and CH_4 are tabulated for the different systems. Plots of the CO_2/CO versus dose demonstrate that it is reasonable to use the CO_2/CO ratio as an internal dosimeter for alkane-oxygen systems undergoing radiolysis providing a calibration curve is obtained for each system. (B.L.M.)

11558 POLYMERIZATION OF NUCLEOTIDES BY GAMMA RADIATION. Aguilera, A.; Gampel, Z.; Pieber, M.; Toha, J. (Univ. de Chile, Santiago). Photochem. Photobiol., 7: 711-20 (June 1968).

The polymerization of nucleotides by γ radiation is described. A ^{137}Cs source was used, with two radiation devices, one static and one dynamic. The latter allowed irradiation of the solution and simultaneous isolation of the biggest polymers. The total dose was 10^5R (200R/min). The polymers (insoluble in ethanol) obtained can be isolated by DEAE-cellulose column chromatography, dialysis, paper chromatography, and Sephadex G-25 and G-50 column chromatography. The yield of polymers diminished when the irradiation was performed in the presence of oxygen or radical trappers (NaCl or HCHO). Highly concentrated solutions of nucleotides and mixtures of nucleosides and nucleotides gave lower yields. Ribonuclease, phosphodiesterase, and KOH hydrolyzed the polymers, but there were fractions that remain nonhydrolyzed. In column chromatography they behaved like partially hydrolyzed commercial polymers, and their P/base ratios were similar. The polymers obtained by irradiation of uridylic acid could be paired with commercial poly A, but not with poly U, and the paired polymers were denatured by heating and renatured by cooling. Preliminary studies showed that the radiopolymer of uridylic acid stimulates the incorporation of phenylalanine-^{14}C to the acid-insoluble material of an in vitro system of biosynthesis of proteins. Radiopoly A stimulated the incorporation of lysine-^{14}C in the same system. With γ irradiation, mononucleotides were incorporated into polynucleotides, RNA or DNA; and when seeds were irradiated in the presence of nucleotides, radiosensitivity was induced. The biological implications of these facts and the possible mechanisms of this polymerization are discussed. (auth)

11559 RADIOLYSIS MECHANISM OF AQUEOUS SOLUTIONS OF RIBOSE. Kochetkov, N. K.; Kudryashov, L. I.; Chlenov, M. A.; Sharpatyi, V. A.; Nadzhimiddinova, M. T.; Nikitits, I. V.; Emanuel, N. M. (Inst. of Organic Chemistry, Moscow. Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR, 183: 376-8(Nov. 11, 1968). (In Russian).

The radiolysis of frozen solutions of ribose and their final and intermediate products was studied at –78 and –196°C using as the radiation source ^{60}Co with 0.75×10^{16} eV/ml sec dose and 1.6-MeV electron accelerator. According to the EPR spectra two groups of radicals (formed from water, OH, and e_{aq} and from dissolved ribose) were observed at –196°C. With the temperature rise the HO radicals disappear first by self combination forming H_2O_2 and by the reaction $RH + OH \rightarrow R + H_2O$. With heating the specimen up to –60° and above the structure of EPR spectra was altered significantly as in the case of irradiated solutions of disaccharides. A possibility of stereochemical changes in the initial ribose molecule was postulated on the basis of EPR measurements made in irradiated frozen aqueous ribose solutions. The experiments also indicated the possibility of direct epimerization in the radiolysis processes of each of asymmetric centers of monosaccharide forming saccharose with different stereochemistry. (R.V.J.)

11560 RADIATION-INDUCED POLYMERIZATION IN SOLID STATE. Tabata, Yoneho (Tokyo Univ.). Kobunshi, 17: 758-66(Aug. 1968). (In Japanese).

By dividing the reaction conditions for radioinduced solid-state polymerization into those of the radiation source and of sample materials, and then combining the two, it is shown that such conditions can be varied over a wide range. And several examples of the special conditions are presented. To clarify the mechanisms of solid-state polymerization reactions, studies by direct methods are made. The method of detecting active species, lattice defects, and voids in the system, by measurement of positron life in the irradiated solid monomer, provides a clue for the study of solid-state polymerizations. (NSA of Japan)

11561 RADIOLYSIS OF RAFFINOSE TYPE OLIGOSACCHARIDES IN SOLID STATE. 1. IDENTIFICATION OF PRODUCTS. Maeda, Masaakira; Murakami, Susumu (Saitama Univ., Japan). Sci. Rep. Saitama Univ., Ser. A, 6: No. 1, 5-16(Mar. 1968).

Extensive radiolysis of solid oligosaccharides of the raffinose type was effected by irradiation with different dosages of γ radiation from ^{60}Co. The minimal dosage required for radiolysis was estimated to be 510×10^4 r/h for sucrose and raffinose, and 54×10^4 r/h for stachyose. With sucrose, degradation of crystalline structure was observed as the initial reaction followed by the cleavage of glycosidic bond. However, synthetic reactions, leading to the formation of other oligosaccharides than sucrose did not occur even at 6600×10^4 r/h. Radiolytic cleavage of the glycosidic bonds in raffinose was initiated by the liberation of D-fructose leaving melibiose, which was further split into a mixture of D-galactose and D-glucose by irradiation with higher dosage. In addition, the formation of unknown oligosaccharides was also recognized as the reaction products. Although the mechanisms remained unknown, rebinding of activated sugar residues produced during radiolysis is a feasible explanation for synthetic reaction. In irradiation of stachyose, in the first step of radiolytic reaction, the terminal galactosyl residue was liberated, which immediately combined to other sugar molecules yielding higher oligosaccharides than stachyose. With further increase in dose, cleavage occurred at the glycosidic bond involving β-fructofuranosyl residue in a manner similar to raffinose. (NSA of Japan)

11562 CORRECTIONS FOR RECOIL LOSS IN STUDIES OF RECOIL TRITIUM REACTIONS. Root, John W. (Univ. of California, Davis); Rowland, F. S. Contracts AT(11-1)-407; AT(11-4)-34. Radiochim. Acta, 10: 104-5(1968).

From experimental measurements of recoil range, or the reciprocally related quantity, stopping power, available for a few molecules for tritons and from reasonable assumptions concerning the stopping power of electrons in different electron shells, a more extensive set of stopping powers and ranges were calculated and are tabulated. A sample calculation of the recoil loss of tritons in a gaseous mixture is given. (B.L.M.)

11563 SIMULTANEOUS POLYMERIZATION OF A PLURALITY OF MONOMER STREAMS IN A SINGLE REACTOR USING IONIZING RADIATION. Gardner, John B.; Smith, Charles F.; Harper, Billy G. (to Dow Chemical Co.). U. S. Patent 3,414,499. Dec. 3, 1968. Filed Feb. 25, 1965.

A device and a process are described for simultaneously polymerizing a plurality of streams of unsaturated monomeric materials with ionizing radiation. The central core of the reactor contains a source of high energy radiation and is surrounded by a number of concentric tubular reactor shells to form angular spaces at different distances from the core. One or more radiation polymerizable monomers are simultaneously passed through the annuli of the reactor to produce separate polymer streams polymerizing different monomers simultaneously but separately polymerizing a single monomer to separate products having different molecular weight ranges while effectively utilizing the energy from the radiation source. (Offic. Gaz.)

11564 APPLICATION OF NUCLEAR MAGNETIC RESONANCE TO THE STUDY OF GRAFT COPOLYMERS OF CELLULOSE [PRODUCED] BY IRRADIATION. Vincendon, M. (CEN, Grenoble, France). Peintures, Pigments, Vernis, 43: 164-70(1967). (In French).

The simultaneous γ-irradiation of cellulose and styrene was shown by NMR spectrometry to produce a graft copolymer containing between 10 and 20 cellulose chains for each polystyrene chain. Fractionation by precipitation demonstrated the homogeneity of the copolymer, and treatment with a reagent for sever-ing ether linkages showed the existence of ether-type attachments of multiple cellulose chains to the polystyrene chains. (Anal. Abstr.)

11565 CROSS-LINKING OF POLYMERIC SUBSTANCES WITH ACETYLENE AND IONIZING RADIATION. Shinohara, Yasuo; Yamaguti, Kenji; Nagai, Teruo (to Toyo Rayon Kabushiki Kaisha). U. S. Patent 3,414,498. Dec. 3, 1968. Priority date Apr. 9, 1963, Japan.

A process is described for improving the properties of polymers by subjecting the polymers to ionizing radiation to reform them and by bringing them into intimate contact with acetylene either before, during, or after the irradiation. The acetylene may be either gaseous acetylene alone or in a mixture with another gas or with an inert liquid. (Offic. Gaz.)

11566 GRAFT COPOLYMERIZATIONS OF GASEOUS VINYL CHLORIDE AND VINYLIDENE CHLORIDE ON PREIRRADIATED POLYPROPYLENE. Hayakawa, Kiyoshi; Kawase, Kaoru (Government Industry Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikenko Hokoku, 17: No. 7, 167-74(July 1968). (In Japanese).

The graft copolymerizations onto preirradiated polypropylene fibers of gaseous vinyl chloride and also of gaseous vinylidene chloride were carried out. The fibers were preirradiated with γ rays from a ^{60}Co source at –78°C in air to a total dose of 8×10^5 RAD, and the volume decrease of monomers at constant pressures due to the sorption and the grafting reaction was followed automatically at temperatures ranging from –10 to 80°C. The net monomer consumption through the grafting process was estimated by subtracting the volume change due to the sorption from the total volume change of monomers. At the higher grafting temperature, the extent of grafting was less and the diminution rate of the grafting activity of fibers was also accelerated. The grafting was found to increase almost linearly with the logarithm of the reaction time and that of the radiation dose to the fibers. At a given reaction temperature the extent of grafting was also proportional to the vapor pressure of the monomer and was assumed to be controlled by the amount of the monomer adsorbed. Increasing the irradiation temperature above 0°C brought about a marked decrease in the activity of preirradiated polypropylene. The grafting activity was successfully retained by the polymer for at least a fortnight at –78°C. (NSA of Japan)

11567 STATUS AND PROBLEMS OF INDUSTRIALIZATION OF RADIATION CHEMISTRY. Sawayanagi, Shoichi; Kasamatsu, Tomomichi (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 14: No. 9, 51-4(Sept. 1968). (In Japanese).

The present state of radiation chemistry and the problems of irradiation techniques are described, with emphasis on the state at the Takasaki Research Establishment of JAERI: the present state of industrial utilization of irradiations, the future uses (synthesis of low molecular compounds, synthesis of high molecular compounds, improvement of polymers, irradiation of foods and medical instruments), irradiation devices, and the present state and future of irradiation techniques. (NSA of Japan)

11568 METHOD FOR PRODUCING HYDROCARBON FLUORIDE WITH IODINE. Katsushima, Atuo (to Daikin Kogyo Co., Ltd.). Japanese Patent 1968-20282. Aug. 31, 1968. Filed Feb. 8, 1964.

The method proposed has the following advantages: the product is obtained with high selectivity without dissociation or polymerization of the carbon fluoride and the reaction proceeds at ordinary temperature and pressure and with rapid velocity. To obtain the fluorohydrocarbon containing iodine, $R_f-(CF_2-CFR_f')_nI$, R_fI and $CF_2 = CFR_f'$ are allowed to react by irradiation with ionizing radiation. Here, R_f is the perfluoroalkyl group of carbon number 1 to 30 having no side chain; R_f' is fluorine or the trifluoromethyl group; n is an integer from 1 to 10. (NSA of Japan)

11569 METHOD FOR POLYMERIZING FORMALDEHYDE. Fukui, Kenichi (to Sumitomo Chemical Co., Ltd.). Japanese Patent 1968-19556. Aug. 23, 1968. Filed July 25, 1963.

The high polymer of formaldehyde, produced by the method, has superior thermal and mechanical properties, sufficiently applicable as a plastic. A mixture of liquid formaldehyde and a nonsolvent, to which an acid anhydride was added, was exposed to supersonic waves and simultaneously either heated at –20° to +50°C or irradiated with ionizing radiation. After completion of the reaction, high-frequency supersonic waves were used to separate the high polymer. (NSA of Japan)

11570 ON A TECHNIQUE FOR INVESTIGATING THE RADIATION–CHEMICAL STABILITY OF IONITES. Semushin, A. M.; Kuzin, I. A.; Galitskaya, I. A. (Leningrad Technological Inst. Lensovet, USSR). Kolloid. Zh., 30: 466-9(May-June 1968). (In Russian).

Special vessels are described for measurement of the amount of gas formed by irradiation of swollen ion exchange resins, and also for the collection of gaseous products analysis. The loss in weight on irradiation of the resins studied is generally large enough to require a correction in calculating total loss of the capacity of the irradiated resin; results are presented for several anion and cation exchange resins. When irradiated with doses near 2×10^8 RAD, the following resins show % corrected losses of capacity: KU-2-8, 19%, SG-1, 6%; AN-2F, 24%; EDE-10P, 36%. Formulas are derived for calculation of changes in volume capacity of resins, moisture capacity, and hydration coefficient. Samples irradiated have the following hydration coefficients (mmole H_2O/mg eq); compared with the unirradiated sample: KU-2-8, 16.8 vs 14.7; SG-1, 65 vs 9.7; AN-2F, 27.0 vs 14.6; EDE-10P, 121 vs 16.7. (BBB)

11571 THE RADIATION-INDUCED ISOMERIZATION OF STILBENE IN 2-PROPANOL AND ACETONE. Lehmann, H. P. (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger.). J. Phys. Chem., 73: 20-5(Jan. 1969).

The radioinduced isomerization of stilbene was studied in 2-propanol and acetone. In 2-propanol the precursors of the trans-to-cis isomerization are shown to be ionic species, while an energy-transfer mechanism is operative in acetone. The cis-to-trans isomerization in both solvents was found to be catalyzed by radioproduced intermediates of the solvents, most probably electrons. In mixtures of acetone in 2-propanol the amount of isomerization of trans-stilbene indicated that a reaction between acetone triplets and 2-propanol was competing with the energy-transfer process between acetone triplets and trans-stilbene. (auth)

11572 PEROXIDE FORMATION IN THE γ RADIOLYSIS OF AERATED AQUEOUS SOLUTIONS OF METHYL IODIDE. Shankar, J.; Rama Rao, K. V. S.; Shastri, L. V. (Bhabha Atomic Research Centre, Trombay, India). J. Phys. Chem., 73: 52-7 (Jan. 1969).

In the γ radiolysis of aerated aqueous solutions of CH_3I, with added KI, the major products formed are hydrogen peroxide, iodine, and methyl hydroperoxide. The initial G values of these products are compatible with the known yields of the primary species (e^-_{aq}, H, and OH) from water. Addition of iodine greatly reduces the yield of methyl hydroperoxide and that of methanol enhances the hydrogen peroxide yield. A sequence of reactions was proposed in order to explain the effects of variation in the concentrations of the solutes, pH, and dose rate upon the product yields. It is shown that the capture of e^-_{aq} by CH_3I is dissociative (i.e., $CH_2I + e^-_{aq} \rightarrow CH_3 + I^-$) ruling out any reaction of the anion CH_3I^- itself (e.g., $CH_3I^- + H^+ \rightarrow CH_4 + I$), and the methyl hydroperoxide is formed by the reaction of CH_3O_2 radicals with iodide ions or I_2^- radical ions, more likely the latter. Relative rate constants determined in neutral solutions are ke^-_{aq}, $H + CH_3I/ke^-_{aq}$, $H + O_2 = 0.4$ $kCH_3 + I_2$ $kCH_3 + O_2 \simeq 1.6$, and $kOH + CH_3OH/kOH + CH_3I = 0.65$. (auth)

11573 STUDY ON DISTRIBUTION OF MOLECULAR WEIGHT IN RADIOINDUCED SOLID-STATE POLYMERIZATION. 1. THEORETICAL TREATMENT. Ohnishi, Teruaki; Tabata, Yoneho (Tokyo Univ.). Kobunshi Kagaku, 25: 809-16(Dec. 1968). (In Japanese).

Distribution of molecular weight of polymers obtained by solid-state polymerization was calculated theoretically. In this calculation, three rate constants, k_p for propagation, k_q for chain transfer and k_t for unimolecular termination were simply introduced. The distribution of molecular weight for post-polymerization was calculated and then the distribution for in-source-polymerization was derived as the superposition of distributions obtained in post-polymerizations which start at different times. It was shown in the theory that two peaks in the distribution can be expected if the chain transfer reaction takes place during polymerization. It was indicated that the mechanism of solid-state polymerization can be explained by the calculated distribution of molecular weight. (NSA of Japan)

11574 RADIOINDUCED GRAFT-POLYMERIZATION ON FLAKY GLASS SURFACE. Higashide, Fukuji; Kanazawa, Yoshiko (Shizuoka Coll. of Pharmacy, Japan). Kobunski Kagaku, 25: 803-8(Dec. 1968). (In Japanese).

The graft-polymerization of methyl methacrylate (MMA) by γ irradiation on the surface of flaky glass was investigated. It was found that the graft-polymerization of MMA on the alumino–silicate glass occurred upon irradiation at room temperature (or –196°C) only when the latter was previously treated with $K_2Cr_2O_7-H_2SO_4$ solution. In the case that alkaline silicate glass or silica powder was used, the grafting was not observed. Infrared spectrum, pyrolysis curve, and gas chromatogram were run to prove the grafting. Infrared absorption band at 1720 cm^{-1} of the grafted glasses was assigned to the carbonyl group of polyMMA, and the gas chromatogram of the pyrolyzate was identical with that of a commercial polyMMA. ESR spectrum was taken to investigate the defects in the glass produced by irradiation. The spectrum of the irradiated alumino–silicate glass pretreated with $K_2Cr_2O_7 - H_2SO_4$ solution showed the lines with six hfs peaks spaced equally (20.6G) whose center was at g = 2.003. No such characteristic resonance lines were found in the ESR spectrum of other glass samples. This result clearly indicates that the defect is electron center trapped at three-coordinated aluminum, which is formed by losing one oxygen from the tetrahedron shaped AlO_4 lattice. The relation between irradiation defects and graft-polymerization, and the role of the treatments were discussed. (NSA of Japan)

11575 ESR AND THERMOLUMINESCENCE OF GAMMA-IRRADIATED FUSED BORAX. Bettinali, C.; Granati, P. (Univ., Rome). Z. Phys. Chem. (Frankfurt), 62: 280-9(Dec. 1968).

The thermoluminescence and ESR of gamma-irradiated fused borax was investigated. At doses of 10^6 r six peaks were found. The 170°C peak (heating rate 10°C/min) is related to the ESR absorption having a mean g value of 2,0014. The thermal annealing of the ESR sample shows an exponential law with an activation energy of 0.31 eV. The buildup curve of thermoluminescence of the 170 and 200° peaks seems to be related to the filling of preformed centers. A more complex law was found for other peaks. (auth)

11576 ELECTRON MICROSCOPY OF RADIATION INDUCED CELLULOSE GRAFT POLYMERS. Goynes, Wilton R.; Carra, Jarrell H.; Blouin, Florine A. (Dept. of Agriculture, New Orleans, La.). pp 34-5 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967. See CONF-670819.

Electron microscopy was used to investigate the location and distribution of the graft polymer in γ radioinduced reactions between cellulose and polyacrylonitrile, polystyrene, poly(methyl methacrylate), and polyvinyl acetate. It was found that distribution of the grafted polymer was dependent on such factors as type of polymer solvent used, cellulose-polymer ratio, functional groups present in the fibers, irradiation dosage used, and whether post irradiation polymerization or simultaneous polymerization was employed. Location of the graft polymer was determined microscopically by applying solvents for cellulose and for the graft polymer to the grafted fibers or their ultrathin cross sections. That portion of the section which was insoluble in either solvent was accepted as the grafted copolymer. (P.C.H.)

11577 EFFICIENCY OF RADIATION CROSS LINKING OF POLYOLEFINS AS A FUNCTION OF THE EXTENT OF THEIR CRYSTALLINITY. Sirota, A. G.; Fedotov, B. G.; Ryabikov, E. P.; Gol'denberg, A. L.; Li'chenko, P. A.; Kharitonova, O. K. (State Scientific Research Inst. of Polymerization of Plastic Materials, Moscow). Dokl. Akad. Nauk SSSR, 183: 393-5(Nov. 11, 1968). (In Russian).

Radioinduced cross-linking of polyolefins as a function of the degree of crystallinity was studied with specimens of up to 50μ foils and 7 mm tall cylinders of low-pressure polyethylene, ethylene copolymers with propylene, and ethylene copolymers with 1-butene of variable crystalline branching, irradiated by 2-MeV electrons in inert media at room temperature. The results obtained confirmed the relationship between the weight coefficient of irradiated polyolefin swelling and the degree of crystallinity. During irradiation with relatively small doses (10 to 20 Mrad), the cross linking efficiency is higher in polyolefins with smaller crystallinity. However, with higher doses (up to 100 Mrad) such dependence was not observed. This indicated that the cross linking takes place mainly in amorphous areas of polyolefins. Under irradiation with up to 400 Mrad the crystallinity of polyolefins did not change. It was assumed that the conservation of crystalline phase at certain doses created favorable conditions for free radical capture. The EPR method was used for studying the kinetics of captured radical disappearance of various temperatures. (R.V.J.)

11578 ABSTRACTION OF HYDROGEN ATOMS FROM HALOMETHANES BY RECOIL TRITIUM ATOMS. Tachikawa, E.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Amer. Chem. Soc., 91: 559-62(Jan. 29, 1969).

Yields of the abstraction reaction by recoil tritium, T + RH → HT + R, were measured for 14 halomethanes in excess perfluorocyclobutene. The yields per C–H bond, $(HT)_F$, expressed relative to methane as 1.0, range from 1.34 (CHF_3) to 14.6 ($CHCl_3$). Progressive substitution of Cl or Br for H gives steadily higher values, while the fluoromethanes exhibit a maximum: CH_3F, 1.70; CH_2F_2, 2.5; CHF_3, 1.34. These trends are explained by the progressive weakening of C–H bonds with additional halogen substituents, coupled with a strengthening of the C–H bond by polar effects with multiple fluorine atom substituents. Comparison with hydrocarbon values leads to the postulate that residual radicals are more excited for RH = hydrocarbon than for RH = fluoromethane. The values of $(HT)_F$ are postulated to correlate with a combination of the bond dissociation energy of R–H and the excess internal excitation energy of the residual radical R formed by the abstraction reaction. (auth)

11579 STUDIES ON THE MICROSTRUCTURE OF A FIBROUS HIGH POLYMER AND THE SMALL-ANGLE X-RAY SCATTERING IMAGE. Yasuda, Takeshi; Fujiwara, Yasuharu (Mukogawa Womens Univ., Japan). Mukogawa Joshi Daigaku Kiyo, Shizenkagakuhen, No. 15, 115-20(1967). (In Japanese).

Crystalline trioxane is polymerized in the solid state by irradiation and polyoxymethylene formed. The polyoxymethylene, obtained by the method, was found to have a fibrous structure. The fibrils appeared to have been produced in two-axis-oriented crystal regions. The small-angle scattering image, with the x-ray beam perpendicular to the fiber axis, was an equatorial, diffuse scattering. With the beam parallel to the fiber axis, it was a circular, diffuse scattering. From the results, it was found that the small-angle x-ray diffuse scattering was due to the density difference in fibrils and fibril gaps, and fibrils were oriented randomly around the fiber axes. (NSA of Japan)

11580 ANISOTROPIC HYPERFINE CONSTANT IN ESR SPECTRUM OF IRRADIATED SOLUTION GROWN POLYETHYLENE. Shimada, Shigetaka (Hokkaido Univ., Sapporo); Kashiwabara, Hisatsugu; Sohma, Junkichi; Nara, Shigeo. Jap. J. Appl. Phys., 8: 145-50(Feb. 1969).

ESR spectra from the alkyl-type free radical, $-\underset{(\beta)}{CH_2}-\underset{(\alpha)}{\dot{C}H}-\underset{(\beta)}{CH_2}-$, produced in irradiated crystals of high-density polyethylene (Sholex 6000) grown from 0.025 wt % solution in xylene were studied, and anisotropic hyperfine splitting due to the α-proton was investigated. Hyperfine splitting due to the α-proton, D_α, was obtained as: $|D_\alpha| = 24-5(1-3\cos^2\psi)$ in the unit of gauss, where ψ is the angle between external magnetic field and the direction of the c-axis of the molecule. Spin density at the carbon atom bearing the unpaired electron was calculated as 0.7 from analysis of the spectrum for the mat of crystals. From the observed ESR spectrum for the alkyl-type free radical produced in melt grown crystals, principal values of hyperfine coupling tensor were also estimated as follows: $|A_z| = 13.6$, $|A_x| = 26.0$, and $|A_y| = 40.6$ gauss. These values are very close to the calculated values. (auth)

11581 ON THE RELATIVE IMPORTANCE OF THE BULK AND SURFACE OF A DIELECTRIC IN RADIATION–CATALYTIC PROCESSES. Zhabrova, G. M.; Vladimirova, V. I.; Kadenatsi, B. M. (Inst. of Chemical Physics, Moscow). J. Catal., 12: 238-44(Nov. 1968).

The contribution from bulk and surface to radiation-catalytic conversion of methanol was studied for a set of samples of two dielectrics: silica gel and aluminum oxide. The extent of methanol conversion for the same amount adsorbed and for the same dose of energy taken up depends neither on the specific surface, nor on its coverage or sizes of the adsorbent globules, but is a function only of the relationship between the amount of adsorbed substance and the number of excess charge carriers formed in the bulk of the solid. The diffusion of charge carriers under the action of ionizing radiation does not interfere with the radiation-catalytic process and adsorbed molecules act only as effective surface traps (holes) for charge carriers. This conclusion is consistent with the concept that practically all excess charge carriers formed in the bulk of the dielectric take part in the radiation chemical process occurring on its surface. (auth)

11582 KINETICS OF HIGH-INTENSITY ELECTRON-BEAM POLYMERIZATION OF A DIVINYL URETHANE. Labana, S. S. (Ford Motor Co., Dearborn, Mich.). J. Polym. Sci., Part A-1, 6: 3283-93(Dec. 1968).

The kinetics of high-intensity electron beam-induced polymerization of di(2′-methacryloxyethyl)-4-m-phenylenediurethane during the network formation has been studied up to complete gelation and up to 56% conversion of unsaturation. From experimentally determined gel fractions, rate of disappearance of unsaturation, kinetic chain length, and intensity dependence, it is proposed that the polymerization takes place in a swollen network where the growing chains undergo unimolecular termination, and where gel–gel reaction is prohibited. The rate expression derived is: $\ln[\alpha(1-g)^{0.545}] = \ln \alpha_0 - 2.51\, k_i k_p t/k_t$, where α is the total unsaturation and g is the gel fraction. The value of K_p/k_t was found to be 2.1 and that of G_R, the free radical yield per 100 eV absorbed, to be 16; these high values are ascribed to the high viscosity of the polymerizing system. (auth)

11583 CHEMISTRY AND PHYSICS OF HIGH ENERGY REACTIONS. Henley, Ernest J.; Johnson, Everett R. (eds.). Washington, D. C., University Press, 1969. 480p. $18.50.

The complex high-energy reactions in radiation chemistry are analyzed in terms of physicochemical principles. The following topics are covered: nomenclature, interaction of radiation with matter, radiation sources, radiation dosimetry, chemical consequences of the absorption of high-energy radiation, modern techniques in radiation chemistry, radiation chemistry of gases, radiation chemistry of water and aqueous systems, effect of radiation on liquid hydrocarbons, radiation chemistry of solids, radioinduced polymerizations, effects of radiation on polymers, and industrial applications. (M.C.G.)

11584 BURNING RATE OF COMPOSITE PROPELLANTS CONTAINING IRRADIATED AMMONIUM PERCHLORATE. Pittman, Charles U. Jr. (Univ. of Alabama, University). J. Spacecraft Rockets, 6: 87-9(Jan. 1969).

Propellants, prepared from γ-irradiated and normal ammonium perchlorate covering a wide range of fuel-to-oxidizer ratios and ammonium perchlorate particle sizes, were burned at pressures of 15 to 1500 psi. The results demonstrated that the γ irradiation of ammonium perchlorate in propellants covering wide ranges of ammonium perchlorate particle size and propellant stoichiometry did not cause appreciable changes in burning rate, r_b, at pressures of 500 to 1500 psi, but it did cause consistent increases in r_b at 1 atm. Thus, it was concluded, that at 1 atm significant subsurface decomposition of ammonium perchlorate could occur to change the overall burning rate, and irradiated ammonium perchlorate could decompose faster and generate more subsurface heat than normal ammonium perchlorate, causing propellants containing irrdiated ammonium perchlorate to burn faster. (P.C.H.)

11585 YIELD OF OZONE IN THE PULSE RADIOLYSIS OF GASEOUS OXYGEN AT VERY HIGH DOSE RATE. USE OF THIS SYSTEM AS A DOSIMETER. Ghormley, J. A.; Hochanadel, C. J.; Boyle, J. W. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 50: 419-23(Jan. 1, 1969).

A yield of ozone of 13.8 ± 0.7 molecules/100 eV was determined in the pulse radiolysis of oxygen at 1 atm by high-energy electrons at a dose rate of 10^{12} rads/sec. The absorbed dose was based on the energy absorbed in a thin aluminum calorimeter. While this yield is somewhat higher than a recently reported value of 10.2 ± 0.6 determined from the initial rate of formation in radiolysis by cobalt γ rays at low dose rate, it is likely that there is little or no dose-rate dependence over the range from 10^2 to 10^{12} rads/sec. This system provides a simple and accurate dosimeter, and the in situ measurement of ozone offers the added advantage for systems in which the electron flux is nonuniform, that the average absorbed dose in the optical path is measured. (auth)

11586 RADIATION-CHEMICAL TRANSFORMATIONS OF HYDROGENATED TERPHENYLS. Kiss, Istvan; Roder, Magda (Magyar Tudomanyos Akademia Koezponti, Budapest). Magy. Kem. Foly., 74: 336-8(1968). (In Hungarian).

The radiation stability of 1,4-, 1,3-, and 1,2-dicyclohexylcyclohexane and ortho-, meta-, and para-dicyclohexylbenzene on irradiation by ^{60}Co, γ rays and in a reactor was determined by measurement of the gaseous and polymeric products. The radiation stability increased in the order ortho, meta, para and the presence of one aromatic ring in the compound increased its stability approximately 5 times in comparison to the stability of the corresponding saturated compounds. The yields of gaseous and polymeric products did not depend on the dose rate nor the form of radiation, but, in the case of incompletely hydrogenated terphenyls, the yields depended on the linear density of energy transfer. Approximately 90% of the energy absorbed proportionally in the electronic parts in saturated groups is transferred to aromatic parts of the molecule. (tr-auth)

11587 INFLUENCE OF CHEMICAL AGENTS ON RADIOCHEMICAL POLYMERIZATION OF ACRYLAMIDE, OF METHACRYLAMIDE, AND OF SOME N-TERT-ALKYLACRYLAMIDES. II. EFFECTS OF INHIBITORS AND WATER. Swiderski, Jan; Zurakowska-Orszagh, Janina (Univ. of Warsaw). Rocz. Chem., 42: 1691-6(1968). (In Polish).

Investigations on the effects of hydroquinone addition and on the presence of water on the rate of radioinduced solid-state polymerization of acrylamide, methacrylamide, and some N-tert-alkylacrylamides were carried out. (auth)

11588 RADIATION GRAFTING OF VINYL FLUORIDE TO POLY(VINYL CHLORIDE) IN THE PRESENCE OF SOLVENTS. Usmanov, Kh. U.; Yul'chibaev, A. A.; Asamov, M. K. (Tashkent State Univ.). Uzb. Khim. Zh., No. 4, 56-8(1968). (In Russian).

Experiments were made with radioinduced polymerization of vinyl fluoride to poly(vinyl chloride) in the presence of dichloroethane and dioxane solvents. Data obtained showed that vinyl fluoride grafting reduced the swelling and temperature of vitrification and raised the thermal stability of poly(vinyl chloride). (R.V.J.)

Radiochemistry

11589 CHEMICAL TRANSFORMATIONS ASSOCIATED WITH THE REACTION (n,γ) IN TELLURIC ACID. CONTRIBUTION TO THE STUDY OF THE RETENTION OF Te*(VI) FOR THE ISOTOPES OF SHORT HALF-LIFE: ^{129}Te AND ^{131}Te. Stevovic, J.; Muxart, R. (Institut de Physique Nucleaire, Arcueil, France). Radiochim. Acta, 9: 76-84(Aug. 1968). (In French).

The retention for Te(VI) after (n,γ) reaction in solid H_2TeO_4 was determined for both isotopes ^{129}Te ($t_{½}$ = 69.5 min) and ^{131}Te ($t_{½}$ = 25 min) in the ground state. The aim of these investigations was the study of a possible isotopic effect between the two isotopes which may eventually be reflected in different relative values of the retention. The neutron irradiations were carried out in a reactor of 10^{10} cm^{-2} sec^{-1} neutron flux. The γ-dose was of the order of 10^5 r/h. Since the isotopes ^{129}Te and ^{131}Te have comparable mean life times the samples of H_2TeO_4 were irradiated under the same conditions. The irradiation times were in general 10 and 20 min. In some experiments longer irradiation times (40, 60, and 180 min) were applied in order to find out the influence of irradiation time upon the retention. The influence on the measurement of the two Te isotopes under consideration of the presence of other Te isotopes which are simultaneously formed by the neutron irradiation was also investigated. The results show a slight increase of the retention with increasing irradiation time. For ^{129}Te the retention increases from 39.7 to 45.6% in passing from 10 to 20 min of irradiation. The retention reaches a constant of 49% after three hours of irradiation. In case of ^{131}Te a constant value of the retention is reached after 20 min of irradiation. No isotopic effect was observed for an irradiation of 10 min. The experiments with an irradiation time of 20 min, however, show a difference of 6.7% in the relative values of the retention for both isotopes the retention for ^{129}Te being higher than the one of ^{131}Te in all experiments. It is assumed that the dependence of the retention on the irradiation time is connected with the γ-contamination in the reactor. (auth)

11590 GAMMA RAYS OF SHORT-LIVED XENON ISOTOPES. Tomura, Kenji; Miyaji, Nobuyoshi (Rikkyo Univ., Yokosuka, Japan). Radiochim. Acta, 10: 173-4(Dec. 1968).

A solvent extraction method was used for a study of the γ radiation of short-lived Xe isotopes, essentially ^{137}Xe and ^{138}Xe. Natural uranyl nitrate hexahydrate (15 to 20 mg) was irradiated in a neutron flux of 5 × 10^{11} n/cm^2 for 3 min. The material was transferred to a 50 ml separatory funnel, together with 10 ml of CCl_4 and 10 ml of H_2O containing a few drops of 1 M $NaHSO_3$. The organic phase was separated and washed. In this condition the Xe sample was used for measuring the γ spectrum with a calibrated Ge(Li) detector of about 8 cc active volume. Half-life measurements are given. In ^{137}Xe only one γ ray was observed, with an energy of 455 ± 1 keV. Gamma energies for ^{138}Xe are tabulated. The results are explained. (P.C.H.)

11591 NOVEL METHOD OF ^{14}C-LABELING. PREPARATION OF CARRIER-FREE NITRILES VIA THERMAL DECOMPOSITION OF NEUTRON-IRRADIATED Cu_3N IN THE PRESENCE OF ORGANIC SUBSTRATES. Stoecklin, G.; Vogelbruch, K. (Kernforschungsanlage, Juelich, Ger. Univ., Cologne). Radiochim. Acta, 10: 177-9(Dec. 1968).

The thermal decomposition of neutron irradiated Cu_3N was used to set free the trapped ^{14}C species in the presence of organic substrates in order to produce labeled nitriles. Cu_3N decomposes at about 500°C into active N and Cu. A slow decomposition (20 to 500°C in 30 min) in the presence of 1 atm of ethane led to the formation of $H^{14}CN$. If the decomposition is carried out in the presence of ethylene/ethane (1:5) acetonitrole-1-^{14}C and acrylonitrile-1-^{14}C are formed. The results demonstrate that ^{14}CN-radicals are either present in the lattice after irradiation or produced during the thermal decomposition of the Cu_3N via reactions of carbon atoms with molecular or atomic nitrogen. The production of other labeled compounds is also discussed along with dose effects. (P.C.H.)

11592 HOT-ATOM CHEMISTRY. Fenger, Jes (Danish Atomic Energy Commission, Risoe). Forsk. Udvikling-Uddannelse (Copenhagen), 77: 269-73(1968). (In Danish).

A review of hot-atom chemistry is presented. After an elementary explanation of why nuclear reactions have chemical consequences, a number of practical aspects in radiochemistry, geology, and genetics are described. (UK)

Separation Processes

Refer also to abstracts 11400, 11472, 11674, 13234, 13409, and 13512.

11593 (ANL-7464) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XX. FISSION-PRODUCT TELLURIUM OFF-GAS DISPOSAL IN THE FLUID-BED FLUORIDE VOLATILITY PROCESS. Vissers, D. R.; Steindler, M. J. (Argonne National Lab., Ill.). Aug. 1968. Contract W-31-109-eng-38. 41p. Dep. CFSTI.

The volatile fluoride species of fission-product tellurium, tellurium hexafluoride, represents a troublesome component in the fluid-bed fluoride-volatility process off-gas system. The problem results from the relatively high concentration of the highly toxic radioactive tellurium found in spent reactor fuels and the chemically inert character of tellurium hexafluoride found in the process off-gas system. Gas sorption with tellurium hexafluoride on various sorbents was studied, both in static and flowing type systems, to evaluate 13 sorbents as potential trapping agents for tellurium hexafluoride. Radio-tagged tellurium hexafluoride was used in the gas-flow studies. These studies revealed that activated alumina can effectively remove tellurium hexafluoride from an off-gas stream containing fluorine. Tellurium hexafluoride removal efficiencies in excess of 99.995% were easily obtained. The heat of sorption for TeF_6 on activated alumina was found to be 4.8 kcal $mole^{-1}$. The TeF_6 sorptive ability of activated charcoal was also investigated. (auth)

11594 (BM-RI-7227) IMPROVED ELUEX PROCESS FOR ELUTING URANIUM FROM ION EXCHANGE RESINS. George, D'Arcy R.; Ross, J. Richard (Bureau of Mines, Salt Lake City, Utah. Salt Lake City Metallurgy Research Center). Feb. 1969. 10p.

An Eluex-type circuit for eluting and recovering uranium from ion exchange resins was developed on a laboratory scale. The improved circuit differs from conventional Eluex practice in that a stage of uranium solvent extraction is coupled with each stage of resin elution rather than having the elution and solvent extraction operations conducted separately. The system reduces the number of stages, retention time, and resin inventory in the elution circuit to one-fourth or one-fifth that in existing circuits. The system is applicable to both resin-in-pulp and moving-bed-type ion exchange uranium recovery circuits. (auth)

11595 (BNWL-814) POT CALCINATION PERFORMANCE DURING FIRST RADIOACTIVE TESTS IN WASTE SOLIDIFICATION ENGINEERING PROTOTYPES: WASTE SOLIDIFICATION PROGRAM. VOL. 4. McElroy, J. L.; Cooley, C. R.; DeMier, W. V.; Mendel, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.); Suddath, J. C.; Blomeke, J. O. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract AT(45-1)-1830. 155p. Dep. CFSTI.

Solidification of high-level radioactive waste by the pot calcination process was successfully demonstrated. Nearly 4 million curies of radioactivity were processed in six full scale tests. Radioactivity was increased from 85,000 curies in the first run to 1.3 million curies in the sixth run. The rate of heat generation within the pot increased from 600 to 5100 watts. The calcined waste in an 8-in. diameter pot represented 1.2 tons of power reactor fuel (20,000 MWd/ton at 15 MW/ton specific power) after 1 year out-of-reactor. Waste was processed at an overall rate from 12 to 14 l/hr, which was equivalent to processing wastes from 1 ton/day of spent fuel. From 3 to 30% of the ruthenium in the waste volatilized from the pot; rework of the pot condensate in an evaporator and acid fractionator reduced radionuclides in the final liquid effluent to a concentration acceptable for low-level treatment processes. Cumulative decontamination factors (curies in the waste before solidification/curies accumulated in final liquid condensate) were 10^6 and 10^8 for ruthenium and all other radionuclides, respectively. The calcined solids were stable and did not cause a significant pressure increase within the container after it was capped and welded. (auth)

11596 (BNWL-923) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, August–October 1968. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 35p. Dep. CFSTI.

Spray solidification Run SS-4 was completed with 500 liters of sulfate containing PW-2 waste being reduced to 56 liters of ceramic solid in 40.5 hours. The 1,300,000 Ci of fission product activity interfused in the solidified waste produced an internal heat generation rate of about 5400 watts. Operation of the spray solidification systems was quite smooth, and all the equipment performed satisfactorily. The temporary loss of the mount for the calciner vibrator resulted in an interruption of the run, but a new floating-type vibrator was placed on the calciner and the run was successfully completed. A new method has been developed to control the discharge of melt from the spray solidifier melter. The melt in the discharge valves is solidified by an air stream. To discharge the melt, the cooling air is turned off and the heat from the melter furnace thaws the material in the freeze valve. This method of melt discharge was successfully used during spray solidification Run SS-5. During SS-5, 887 liters of sulfate-free PW-1 waste, containing 2,000,000 Ci of radioactivity, was successfully reduced to 66 liters of ceramic solid in 53.2 hours. All spray solidifier systems performed satisfactorily. Investigation of PW-4m feed formulations indicates that a phosphate rather than a borosilicate flowsheet will be favored for processing PW-4m in the spray solidifier. Among reasons for this are that rare earth precipitates form in the PW-4m borosilicate melts and extreme difficulty is encountered in preparing and handling the borosilicate feeds. In a PW-4m run with the development spray calciner, a PW-4m flowsheet was found suitable for spray solidification when the borate flux was added separately as a solid to the melter rather than including it in the calciner feed. (auth)

11597 (CEA-CONF-1092) CHEMICAL SEPARATION OF FISSION PRODUCTS. Lefevre, J. [1968]. 25p. (In French). (CONF-680539-1). Dep.

From 50th Anniversary of the Society of Industrial Chemistry, Paris, France.

Chemical procedures were developed for the recovery of the fission isotopes, ^{137}Cs and ^{90}Sr. A procedure for the separation of cesium-137, which is being placed on an industrial pilot stage, is described. The procedure is based on the utilization of a "mixed exchanger," a mineral compound containing 80% by weight of zirconium phosphate and 20% ammonium phosphotungstate. Sr-90 can be separated either by liquid–liquid extraction using bis(2-ethylhexyl) phosphate or by ion exchange on antimonic acid. The rare earths, ^{147}Pm and ^{144}Ce, have been considered until now only as by-products of the separation of ^{90}Sr (by liquid–liquid extraction) or of the separation of the transuranium elements, Np and Am. Separation studies on these isotopes are only fragmentary. (tr-auth)

11598 (CEA-CONF-1130) DYNAMIC STUDY AND REGULATION OF AN URANIUM EXTRACTION BATTERY BASED ON PERTURBATIONS OF SMALL AMPLITUDE. Bory, Michel; Degryse, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 14p. (In French). (CONF-680941-1). Dep.

From International Symposium on Analogue and Hybrid Computation Applied to Nuclear Energy, Versailles, France.

The battery is part of a plant for treatment of irradiated nuclear fuels. It is used both in the separation of uranium and plutonium and in the separation of various fission products. Uranium and plutonium are extracted progressively using TBP diluted with dodecane. The analogous study of this system has as its purpose the determination of the dynamic influence of the variations of various parameters in the vicinity of their nominal values. The change in uranium concentration in various stages was studied. Regulation of the battery was obtained by variation of the flow of fluids. It is important to maintain the battery assembly in a functioning condition so that plutonium leaks can be avoided. (J.G.B.)

11599 (HW-83226) THE EXTRACTION OF POLONIUM(IV) AND BISMUTH(III) FROM NITRIC ACID BY SEVERAL ORGANIC SOLVENTS. Sheppard, J. C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). July 20, 1964. Contract AT(45-1)-1350. 16p. Dep. CFSTI.

Dibutyl butylphosphonate, 1,4-diethoxybutane, hexone, dibutylcarbitol, trioctylamine, and Aliquat-336 were examined in an attempt to develop a method for the solvent extraction of Po from Bi with nitric acid as the aqueous medium. Results indicated that it is possible to separate a small amount of polonium from a large quantity of irradiated bismuth. Dibutylcarbitol was found to be the most worthy of further attention since it has the desirable qualities of a relatively high boiling point and can be produced readily on a commercial scale. (J.G.B.)

11600 (ISO-627) FLUORIDE VOLATILITY PROCESSING OF REACTOR FUELS. Szulinski, M. J. (Isochem Inc., Richland, Wash.). Dec. 14, 1966. 9p. Dep. CFSTI.

Basic fluoride volatility process flowsheets and a review of the process are presented. (M.C.G.)

11601 (K-L-6195-2) DESIGN MODEL FOR THE DYNAMIC ADSORPTION OF URANIUM HEXAFLUORIDE ON FIXED BEDS OF SODIUM FLUORIDE. Stephenson, Michael J. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 1968. Contract W-7405-eng-26. 78p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

A mathematical model was developed that describes the dynamic adsorption of uranium hexafluoride on fixed beds of sodium fluoride. This model is intended for the design engineer as a means of sizing sodium fluoride traps for use in uranium hexafluoride collection and purification. The analysis, which requires a digital computer program, is limited to isothermal, isobaric systems where the concentration of uranium hexafluoride in the feed gas is less than 10 mol %. Data obtained from reported experiments with the uranium hexafluoride-sodium fluoride system are compared with calculated results; the closeness of agreement establishes the reliability of the model within the range covered by available data. A discussion of general results is given, including the dependence of adsorber performance on pellet properties and other physical parameters as implied by the behavior of the model. (auth)

11602 (NP-17739) STUDY OF URANOUS NITRATE AS A REDUCING AGENT FOR PLUTONIUM. III. EQUILIBRIUM DATA FOR Pu AND U IN THE HNO_3-TBP-SHELLSOL T SYSTEM. Lopez-Menchero, E.; Salomon, L.; Bardone, G. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). May 1966. 35p. (In French). (ETR-183). Dep.

Data were compiled on the equilibrium of plutonium and of uranium at their principal valences between nitric acid solutions and an organic phase of 30% TBP in an aliphatic diluent. Partition coefficients were measured for various acidities, degrees of saturation of the solvent, of temperature, and in determining most particularly the conditions which simulate the imposed parameters for the functioning of a 1 BX unit for partition of U-Pu in a Purex-type process. (tr-auth)

11603 (NP-17740) STUDY OF THE USE OF U(IV) IN THE SECOND URANIUM CYCLE OF THE EUROCHEMIC PLANT. Salomon, L.; Lopez-Menchero, E.; Ilardi, S.; Lopez de Manterola, E. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). May 1967. 27p. (In French). (ETR-187). Dep.

A series of test-tube experiments, as well as mixer-settler runs, performed on synthetic solutions, containing 20 to 1000 μg Pu/l, showed that it is possible to obtain the required uranium product decontamination when Pu is reduced by suitable quantities of U(IV) in the feed solution of the 2D column. UC solutions from the plant were also studied. (auth)

11604 (NP-17741) INVESTIGATION OF A STANDARD CHEMICAL FLOWSHEET FOR THE USE OF U(IV) IN THE PUREX 1st CYCLE BY MEANS OF COMPLEMENTARY STUDIES IN MIXER-SETTLERS. Salomon, L.; Lopez-Menchero, E.; Ilardi, S. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). May 1967. 47p. (In French). (ETR-186). Dep.

Conditions for the use of U(IV) as plutonium reductant in the U/Pu partition cycle were tested in mixer-settlers runs for Pu concentrations in the range from 16 to 800 mg/l. The solvent degradation effect on the process was checked with gamma-irradiated solutions and on solutions originating in the plant. The risks of reoxidation in the airlifts were considered, so that the performances of the process to be expected with phase ratios up to 10 needed to be determined. (auth)

11605 (ORO-2124-18) EXTRACTIONS OF SEVERAL RARE EARTHS USING A COMBINATION OF THENOYLTRIFLUOROACETONE AND ACETYLACETONE. Woo, Ching (Kentucky Univ., Lexington). 1968. 94p. Dep. CFSTI.

Thesis.

A mixture of thenoyltrifluoroacetone (Htta) and acetylacetone (Hacac) in benzene solution gave higher extractions of rare earths than either chelating agent alone. The enhanced extraction and the shift of the curves to a lower pH range where the concentration of acetylacetonate ions was extremely low suggested that a mixed metal complex species is formed, incorporating both thenoyltrifluoroacetone and acetylacetone in its structure. Using tracer amounts of radioactive $^{152-154}Eu^{3+}$, the mixed extraction system was found to have third power dependence on the concentration of both thenoyltrifluoroacetone and hydrogen ions, but only a first power dependence on the acetylacetone concentration. This indicates the formation of a mixed complex as follows: $M^{3+} + 3\ Htta + Hacac \rightarrow M(tta)_3 \cdot Hacac + 3H^+$. The mixed complexes were obtained from the organic phases for the rare earths Nd, Sm, Eu, Gd, Dy, and Er. The products were isolated as oils which turned viscous on vacuum pumping at elevated temperatures. Infrared spectra, titrimetric analysis of Hacac, and metal oxide determinations were used to confirm the presence of an adduct having the formula of $M(tta)_3 \cdot Hacac$ for each of the rare earths studied. The presence of inorganic anions, such as chloride or nitrate tends to lower the extraction of the rare earths. The extractions of several rare earths, Nd, Sm, Gd, Dy, and Er, are compared in systems of: thenoyltrifluoroacetone in benzene; equal concentrations of both thenoyltrifluoroacetone and acetylacetone in benzene; and thenoyltrifluoroacetone in pure acetylacetone. The results show that while the extraction curve for each rare earth is shifted to the lower pH region, the separations between the neighboring rare earths tend to be smaller in the mixed system. (auth)

11606 (ORO-2124-19) SOLVENT EXTRACTION BEHAVIOR OF THE TRIVALENT LANTHANIDES IN THE ACETYLACETONE-WATER SYSTEM. Rogers, Donald Richard (Kentucky Univ., Lexington). 1968. 283p. Dep. CFSTI.

Thesis.

The properties of acetylacetone were studied as a function of aqueous solution conditions. The solubility of acetylacetone was dependent on ionic strength, the salt used to control ionic strength, and temperature, but independent of pH in the range 1.5 to 7. The extraction behavior of samarium in the acetylacetone-water system was investigated as a function of ionic strength, the salt used to control ionic strength, and the acetylacetonate ion concentration. The presence of sodium perchlorate in the aqueous phase greatly enhances the extraction of samarium into the acetylacetone phase. The solvent extraction equilibria were derived for systems that exhibit more than one extractable species. To avoid the a priori assumption that all the possible species must be present and affect the solvent extraction equilibria, equations were derived for all plausible combinations of possible species in the organic and aqueous phases. A least squares computation method, using the IBM-360/50 high-speed digital computer, was developed to fit the solvent extraction data to the equations that were derived. The criteria for selection of the best mathematical and chemical model are discussed. The stability constants and partition coefficients can be calculated from the least squares extraction parameters. Using 0.5 $\underline{M}$ sodium perchlorate to control the ionic strength of the aqueous phase, the extraction of lanthanum, neodymium, samarium, gadolinium, dysprosium, erbium, and lutetium in the acetylacetone-water system was studied at 10, 20, and 30°C as a function of the acetylacetonate ion concentration. The stability constants of the lanthanide-acetylacetone complexes calculated by the least squares treatment of the solvent extraction data were found to be in reasonable agreement with values reported in the literature. The contribution of each of the extractable species to the total extraction as a function of the acetylacetonate ion concentration was calculated. The general trends in the stability constants and partition coefficients across the lanthanide series are discussed. (M.C.G.)

11607 (UCRL-Trans-10317) CHELATION AND EXTRACTION OF TRIVALENT ACTINIUM, AMERICIUM, CURIUM, AND CALIFORNIUM WITH ACETYLACETONE AND SOME OF ITS DERIVATIVES. Schreck, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut Radiochemie). Translated by W. E. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from report KFK-672. 101p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 25459. (auth)

11608 PLUTONIUM TETRAFLUORIDE PREPARATION AND SEPARATION BY SORPTION ON SODIUM FLUORIDE. Steindler, Martin J.; Jonke, Albert A. (to United States Atomic Energy Commission). U. S. Patent 3,423,190. Jan. 21, 1969.

A method was developed in which plutonium is separated from uranium and fission products present in an irradiated fuel element by fluorinating the element in a fluidized bed and passing the volatile hexafluorides thus formed through a settled bed of sodium fluoride. The sodium fluoride with the plutonium, uranium, and fission products sorbed thereon is heated to 400°C and flushed with fluorine to remove the uranium and volatile fission product fluorides. The sodium fluoride is alternately washed with liquid anhydrous hydrogen fluoride and liquid bromine pentafluoride, which dissolves the sodium fluoride and leaves a purified precipitate of plutonium tetrafluoride. (AEC)

11609 APPARATUS AND METHOD FOR SEPARATION OF HELIUM ISOTOPES. McKinney, John L.; Taylor, William L. (to United States Atomic Energy Commission). U. S. Patent 3,421,334. Jan. 14, 1969.

Helium isotopes were separated from an isotope mixture by reducing the mixture temperature until ^4He partially becomes a superfluid, filtering a portion of the ^4He from the mixture, heating the remaining mixture to boiling with an adjacent outer helium bath, and distilling the vapors to produce high-purity ^{3}He. (AEC)

11610 PROCEDURES AND APPARATUS FOR ELECTRODIALYTIC TREATMENT OF LIQUIDS. (to Wallace Tiernan Inc.). British Patent 1,137,679. Dec. 27, 1968. Priority date Feb. 24, 1965, United States.

A cell is described for effecting changes in concentration of ions in aqueous electrolytic solutions, particularly for desalination of water. The cell is composed of two electrodes, one a hollow outer electrode concentrically surrounding an inner electrode to laterally define a cell region. A number of tubular permselective membranes including at least one cation-permselective and at least one anion-permselective membrane are positioned in the cell region in concentric spaced relation to each other so as to divide the cell region into a number of concentric chambers for receiving the electrolytic solution. The chambers include at least an inner electrode chamber contiguous to the inner electrode and an outer electrode chamber contiguous to the outer electrode. A packed bed of divided solid ion-exchange material substantially fills one chamber. The cell includes a power supply for effecting the passage of a direct current through the chambers between the electrodes in such a direction as to promote migration of the cations into an intermediate chamber through the cation permselective membrane. A process for using the cell for effecting transfer of ions between a first electrolytic solution and a second and third electrolytic solution is described. (B.L.M.)

11611 SYNERGISM IN THE SOLVENT EXTRACTION OF METAL IONS BY DIBENZOYLMETHANE. Healy, T. V. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 31: 499-511(Feb. 1969).

Large synergistic effects were obtained in the extraction of lithium and sodium by dibenzoylmethane (DBM) plus neutral donor solvents (S). Smaller effects were obtained for uranium, much smaller effects for americium, and negligible effects for thorium extraction. The formulas of the synergistically-extracted species are Li(DBM)S_2, Na(DBM)S_2, and UO_2(DBM)$_2$S, where S may be a phosphine oxide, a phosphate, an alcohol, or an amide. Equilibrium constants are reported for these synergistic reactions for a wide range of species. (auth)(UK)

11612 ACIDIC ORGANOPHOSPHORUS EXTRACTANTS. VIII. EXTRACTION OF CERIUM(IV) BY DIBUTYLPHOSPHORIC ACID. Navratil, O.; Dubinin, I. (Faculty of Natural Science, Brno). J. Inorg. Nucl. Chem., 31: 527-32(Feb. 1969).

The distribution of ^{141}Ce between an aqueous solution of nitric, perchloric, or hydrochloric acid, in the presence of $NaBrO_3$, and dibutylphosphoric acid solution in CCl_4 was studied. Ce is oxidized to the tetravalent state only in HNO_3 medium, the $Ce(NO_3)_4(HDBP)_4$ complex being extracted by the solvation mechanism. In the other two mineral acids, only Ce(III) is extracted, the $D_{Ce(IV)}/D_{Ce(III)}$ ratio achieving a value of even 10^5. When using a mixture of HNO_3 + $HClO_4$ a synergic effect was observed. (auth)(UK)

11613 SYNERGIC SOLVENT EXTRACTION OF EUROPIUM(III) INTO MIXTURES OF 2-THENOYLTRIFLUOROACETONE WITH VARIOUS ALKYLPHOSPHINE OXIDES. Carey, M. A.; Banks, C. V. (Ames Lab., Iowa). J. Inorg. Nucl. Chem., 31: 533-50 (Feb. 1969).

The synergic solvent extraction of tracer europium(III) from chloride medium into mixtures of thenoyltrifluoroacetone (HTTA) with methylenebis(di-n-hexylphosphine oxide) (MHDPO), trimethylenebis(di-n-hexylphosphine oxide) (PHDPO), tetramethylenebis(di-n-hexylphosphine oxide) (BHDPO), or tri-n-octylphosphine oxide (TOPO), in cyclohexane was studied. The europium-containing species in the organic phase were found to be Eu(TTA)$_3$(TOPO)$_2$, Eu(TTA)$_3$(MHDPO), Eu(TTA)$_3$(PHDPO), and Eu(TTA)$_3$(BHDPO). A solvent extraction-molar ratio study using an acetate aqueous medium confirmed these stoichiometries and showed the formation of Eu(TTA)$_3$(TOPO). The formation of Eu(TTA)$_3$(TOPO) was confirmed by a loading capacity study. The synergic solvent extraction of tracer europium(III) from perchlorate medium into mixtures of HTTA and TOPO or HTTA and MHDPO in cyclohexane was also studied. The europium-containing species in the organic phase were found to be Eu(TTA)$_2$(TOPO)$_2$ and Eu(TTA)(ClO_4)$_2$(MHDPO)$_3$. Equilibrium constants for the formation of all of the above complexes were calculated. (auth)(UK)

11614 BEHAVIOR OF 14 RADIONUCLIDES ON MnO_2 COLUMNS. Meloni, S.; Brandone, A. (Univ., Pavia, Italy). Radiochim. Acta, 10: 97-100(1968).

The behavior of 14 radionuclides, in HNO_3 solution, on MnO_2 columns was investigated. The radionuclides were absorbed at different HNO_3 molarities and removed from the column, whenever possible, by using HNO_3 or other elutants. The elutiôn curves are given. Some interesting separations among the alkali metals and among the transition elements are predicted. (auth)

11615 STUDIES ON THE EQUIPMENT FOR RADIOACTIVE WASTES DISPOSAL. Murata, Toshinori; Yusa, Hideo (Hitachi Ltd., Tokyo). Hitachi Hyoron, 50: No. 7, 76-80(July 1968). (In Japanese).

Studies were made on the activated-charcoal filter and the oxygen–hydrogen recombiner, used in the waste treatment system of BWR-type reactors, and also on a device for reducing the volume of solid wastes. The results obtained are: (1) from the adsorption constants, measured for iodine and methyl iodide under given conditions, the overall removal ratio of the activated charcoal filter for the mixed gas can be calculated. This removal ratio can be increased considerably by selection of an activated charcoal having a large adsorption constant for methyl iodide. (2) A recombiner was constructed using a domestic catalyzer comparable with the U. S. Deoxo. (3) Data were obtained for the design of a sludge incenerator for reduction of the volume of solid wastes. (NSA of Japan)

11616 RECOVERY OF ^{137}Cs AND ^{90}Sr FROM FISSION PRODUCTS. Baetsle, L. H.; Huys, D. Ind. Chim. Belge, No. 32, 3-8 (1967). (In French).

The process is based on the selective fixation of the radioelements on mineral ion exchangers, in acid medium. Column packings of molybdenum ferrocynade are used for preferential adsorption of ^{137}Cs and packings of polyantimonic acid for selective fixation of ^{90}Sr. After adsorption the ion exchangers are volatilized by chlorination at 270 to 300°C. The elimination of elution and reconcentration procedures and recirculation of the ion exchangers make the process very economical. (UKAEA Info Bulletin)

11617 RECOVERY OF CESIUM FROM RADIOACTIVE WASTES BY ION EXCHANGE. Piret, J. Ind. Chim. Belge, No. 32, 17-19(1967). (In French).

Selective adsorption of Cs from solutions of nuclear fuel residues on Ti phosphate was studied. Elution by NH_4NO_3 and NH_4Cl and a subsequent elution of Fe^{3+} gave a sufficiently pure radioactive Cs. The influence of the number of cycles on exchange capacity was also examined. (UKAEA Info Bulletin)

11618 SEPARATION OF NITROGEN ISOTOPES BY GAS CHROMATOGRAPHY. Cartoni, G. P.; Possanzini, M. (Univ., Rome). J. Chromatogr., 39: 99-100(Jan. 14, 1969).

An attempt was made to separate ^{14}N and ^{15}N by gas chromatography at 77°K. The carrier gas was a mixture of 55% He and 45% CO. Under the experimental conditions employed, the capacity ratio was too small for the maximum resolving power of the column to be completely realized. The separation factor was 1.006. Results indicate that gas chromatography can be used to separate nitrogen isotopes. (J.G.B.)

11619 CATION EXCHANGE BEHAVIOR OF METAL IONS IN AMMONIUM SULFATE MEDIA. Kawabuchi, Kazuaki; Ito, Takao; Kuroda, Rokuro (Univ. of Chiba, Japan). J. Chromatogr., 39: 61-70(Jan. 14, 1969).

The distribution coefficients of 20 metal ions in acid sulfate media with a strong acid type cation exchange resin, Dowex 50W-X8, are presented. The ammonium sulfate concentration varied from 0.10 to 1.0$\underline{M}$ at a constant concentration of sulfuric acid (0.025M). The coefficients of metal ions become significantly lower in acid sulfate media than those in sulfuric acid media, thus allowing many separations to be conducted at lower sulfate concentrations. The distribution coefficient indicates that differences in distribution coefficients between beryllium and a considerable number of metal ions are large enough for good separation. Results of the separation of beryllium from 23 metal ions are given. The acid sulfate system is also suitable for a clear-cut separation of uranium (VI), thorium and the rare earths in widely varying proportions, even permitting a carrier-free separation of ^{234}Th from uranium. (auth)

11620 TECHNICAL AND ECONOMIC PROBLEMS RELATED TO THE DEVELOPMENT OF RADIOACTIVE WASTE PROCESSING AND UTILIZATION TECHNIQUES. Thiriet, L.; Sauteron, J.; Oger, C. pp 2140-53 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966. (In French).

See CONF-661066(Vol.4).

The various techniques used in processing the radioactive wastes which unavoidably result from the generation of electric power from nuclear sources are reviewed. The relative importance, in nuclear fuel cycles, of the problem raised by these wastes is defined. Emphasis is placed on the economic influence of management policies on the cost of power generation, and hence on the relative position of nuclear energy. A substantial percentage of these wastes can be economically utilized. Attention is drawn to the major technical and economic features of the industry which will come into being as a result of this utilization. The major uses anticipated are discussed. (auth)

11621 COMMERCIAL REPROCESSING OF SPENT NUCLEAR FUEL. Runion, T. C.; Lewis, W. H.; Rodger, W. A. (Nuclear Fuel Services, Inc., Wheaton, Md.). pp 2226-37 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16-20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066(Vol.4).

The commercial reprocessing plant for nuclear fuel at West Valley, New York, is described, and the mechanical head end and Purex solvent extraction process it uses is examined. Problems associated with developing the facility are discussed, and the probable course of commercial reprocessing in the next few years is assessed. (H.D.R.)

11622 FREEZE DRYING OF RADIOACTIVE HYDROXIDES. Puzako, V. D.; Mikshevich, N. V.; Yabrov, A. P. At. Energ. (USSR), 26: 3-7(Jan. 1969). (In Russian).

The freeze drying process was considered as a method for treating radioactive hydroxide slurries resulting from effluent deactivation. The kinetics of the Fe(OH)$_3$ freeze drying, the influence of freeze drying rate on the soggy soil formation, and the behavior of detergents and surface-active agents in the freeze drying process have been studied. The coefficients of radioactive effluents purified by the freeze drying process were determined. During the freeze drying of the radioactive mixture of surface active agents and Fe(OH)$_3$ precipitated from this mixture it was established that the surface active agents do not take a very active part in the transfer of the activity into the condensate and the coefficients of condensate purification may be equal to 10^6. (auth)

11623 COMPOSITION OF TTA-NITRO COMPLEXES OF CAESIUM. Crowther, P.; Jurriaanse, A. (National Nuclear Research Centre, Pretoria). J. Inorg. Nucl. Chem., 30: 3365-8 (Dec. 1968).

Cesium can be extracted into TTA (thenoyltrifluoroacetone) from aqueous media on addition of organic nitro-compounds. A study is described of the nature of the extracting species. Maximum extraction was attained within 1 min, and extraction times were confined to <3 min in order to avoid complications due to hydrolysis of the TTA. It is suggested that a possible role of the nitro-group is to raise the effective coordination number of the metal ion, and a possible structure for Cs(TTA)(ϕNO_2)$_4$ (where ϕ represents a methyl or phenyl group) is proposed, in the form of a 6-coordinated alkali metal chelate. (UK)

11624 PLUTONIUM-URANIUM-MOLYBDENUM FUME CHARACTERISTICS AND SAND FILTRATION. McFee, D. R.; Sedlet, J. (Argonne National Lab., Ill.). J. Nucl. Energy, 22: 641-50(Nov. 1968).

The efficiency of sand for the removal of a Pu-U-Mo alloy fume from air, as well as some of the characteristics of the fume, was investigated. A plasma torch was used to generate the fume. The superficial face velocities at which the fume was drawn through 6-in. depths of sand were adjusted from 1 to 133 fpM, and velocities through 30-in. deep sand columns were adjusted from 1 to 28 fpM. Penetration through 6 in. of sand varied from 0.08 to 0.57% over the full range of velocities. Penetration through 30 in. of sand varied from 0.004% at 28 fpM to 0.019% at 5 fpM. Penetration values for 30 in. of sand followed by a high-efficiency particulate air filter were less than 0.0001%. The geometric mean diameter of the particles was 0.07 μ with a standard deviation of 2.7. Discrete particle sizes ranged from <0.02 μ to 4 μ. The particles consisted mainly of polycrystalline and non-crystalline oxides of Pu, U, and Mo. (auth)(UK)

11625 CATION EXCHANGE EQUILIBRIA IN MIXED SOLVENTS. SORPTION CHARACTERISTICS OF COMMON METALS FROM WATER-DIMETHYL SULFOXIDE-HYDROCHLORIC ACID MIXED SOLVENT. Marple, L. W.; Price, D. Proc. Iowa Acad. Sci., 73: 74-80(1966).

From Iowa Academy of Science, Pella, Iowa. See CONF-660464.

The systematic study of the sorption of Ca, Cd, Co(II), Cu(II), Fe(III), Hg(II), In(III), La, Mn, Ni(II), Th(IV), Pb, Yb, U(VI), and Zn by Dowex 50 × 8 cation exchange resin from dimethyl sulfoxide-water-hydrochloric acid mixed solvent is presented. The sorption characteristics are much the same as those found for acetone-water-hydrochloric acid mixed solvent. Major differences occur in the case of Fe(III), Ca, Mg, and Pb. Many useful separations involving these elements are indicated. (auth)

11626 PROCEEDINGS OF THE IOWA ACADEMY OF SCIENCE. VOLUME 73. The Seventy-Sixth Session, Held at Pella, Iowa, April 15-16, 1966. Meglitsch, Paul A. (ed.). Des Moines, The State of Iowa, 1968. 419p. (CONF-660464).

Papers are presented on botany, chemistry, conservation, physiology, psychology, science teaching, and zoology. Separate abstracts were prepared for two papers. (M.C.G.)

For abstracts of individual papers see: 11625 and 11627.

11627 CESIUM FROM POLLUCITE BY ALUMINUM REDUCTION. Gault, W. A.; Young, T. L.; Wilhelm, H. A. (Ames Lab., Iowa). Proc. Iowa Acad. Sci., 73: 81-96(1966).

From Iowa Academy of Science, Pella, Iowa. See CONF-660464.

Aluminum metal was found to liberate cesium almost quantitatively from pollucite ore when reacted under conditions of operation determined by the experiments described. Ore ground to pass a 150 mesh sieve is mixed with atomized aluminum and the mixture heated under an inert atmosphere in a retort. Pollucite ore from one source yielded its cesium when treated at 950°C for 4 hr while pollucite ore from another source required a temperature up to 1050°C to yield essentially all of its cesium. The cesium metal obtained from pollucite by aluminum reduction is about 90% pure; it contains small amounts of sodium, potassium, rubidium, lithium, and other elements. (auth)

11628 MECHANISM OF THE BACTERIAL REDUCTION OF SULPHATE AND OF SULPHITE FROM ISOTOPE FRACTIONATION STUDIES. Kemp, A. L. W.; Thode, H. G. (McMaster Univ., Hamilton, Ont.). Geochim. Cosmochim. Acta, 32: 71-91 (Jan. 1968).

The fractionation of sulfur isotopes in the reduction of sulfate and of sulfite by the bacteria Desulphovibrio desulphuricans was studied over a wide range of lactate concentration, temperature, electron donor, pH, and conditions of growth using resting cell suspensions and cell free extracts of the bacteria. Isotope effects from 5.1 to 23.7‰ were found for sulfate reduction, and 1.7 to 25.5‰ for sulfite reduction, favoring the lighter sulfur isotope (^{32}S). These results are discussed in terms of a reaction mechanism involving several consecutive steps, favoring a small or large isotope effect, competing for control of the rate. Sulfur isotope distribution patterns reported for various types of marine environment and marine sediment are also discussed in terms of these isotope effects. (auth) (UK)

11629 PREPARATION OF METAL SALT-ION EXCHANGE RESINS AND THEIR APPLICATIONS TO RADIOCHEMICAL ANALYSES. Izawa, Masami; Watari, Kazuo (National Inst. of Radiological Sciences, Chiba, Japan). pp 347-52 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A series of a new type of adsorbents for radionuclides in aqueous solutions was synthesized consisting of an ion exchange resin and an inorganic salt, and their properties were studied. Preparation of the "resins" is simple and easy. For example, "ferric hydroxide-cation exchange resin" can be made by putting a ferric form of a cation resin into a concentrated hydroxide ion solution, and "copper ferrocyanide-anion exchange resin" by putting a ferrocyanide form of an anion resin into a cupric ion solution. The prepared "resins" have combined adsorption properties of both the metal salt and the exchange resin moieties. They are generally non-hygroscopic and granular, so that they can be stored in dry state. In principle, the "resins" can be made by any combination of insoluble metal salts and ion exchange resins. By considering adsorption capacity and exchangeability of metal salts and resins, a wide variety of applications of the "resins" can be made for chemical and radiochemical analyses; e.g., "metal hydroxide-resins" for adsorption of zirconium, ruthenium and alkaline earth ions, "metal ferrocyanide-resins" for specific adsorption of cesium and for mutual separation of alkali metals and of fission products (Sr, Zr, Nb, Ru, Cs, Ce). A few examples of applications of "ferrocyanide-resins" are presented. (auth)

11630 THORIUM SEPARATION BY EXTRACTION IN THE PRESENCE OF BUTYRIC ACID. Pietsch, R.; Sinic, H. (Univ., Graz). Mikrochim. Acta, No. 6, 1287-90(1968). (In German).

A new extraction method is described which permits the satisfactory separation of thorium by means of chloroform in the presence of butyric acid from the following accompanying metals: Ca, Mg, Ba, Pb, Zn, Cd, Be, Ni, and Co. (auth)

11631 DIRECT SEQUENTIAL SEPARATION OF ZIRCONIUM, NIOBIUM, COBALT, IRON, AND ZINC BY ANION EXCHANGE.

Span, M.; Span, J. (Nuclear Inst. Jozef Stefan, Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Vestn. Slov. Kem. Drus., 14-15: No. 1-4, 15-19(1967-1968).

A procedure is proposed, which permits separation of zirconium, niobium, cobalt, iron, and zinc in a single anion exchange column operation. Hydrochloric acid of different concentrations was used as eluent except in the case of zirconium and niobium where mixtures of hydrochloric and hydrofluoric acids were used. The individual decontamination factors for above radionuclides were determined. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 11443, 11444, 11687, 11723, 11738, and 11798.

11632 (BMI-171-16) HYDROLOGIC REDISTRIBUTION OF RADIONUCLIDES AROUND NUCLEAR EXCAVATED SEA-LEVEL CANALS IN PANAMA AND COLOMBIA. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. Charnell, R. L.; Zorich, T. M.; Holly, D. E. (Isotopes-Teledyne, Palo Alto, Calif.). Jan. 7, 1969. Contract AT(26-1)-171. 70p. Dep. CFSTI.

For Battelle Memorial Inst., Columbus, Ohio.

The effects of hydrologic processes on the redistribution of radionuclides around a nuclear-excavated sea-level canal were analyzed. A model was formulated that evaluates these effects in two distinct hydrologic regions: the fallout zone and the canal channel. The model was developed for application to the two proposed sites in Panama and Colombia. Lack of preexcavation field data from these sites has required the use of simple mechanisms of redistribution. In addition to watershed dimensions, the simplified model requires data on the following: soil density, porosity, preexcavation hydrology, long-term infiltration rates, distribution coefficient, depth of channel excavation, and device emplacement. The parameter most important to rate of removal, the distribution coefficient, must be obtained from field measurements. In the fallout-zone segment of the model, the existence of an interflow layer of the order of 10 cm thick eliminates erosion by overland flow for all but the greatest rainfall rates. This condition reduces the necessity of examining redistribution effects from each storm. Weekly average rainfall values are sufficient to determine the rate at which a radionuclide is leached from fallout. For the canal channel, flow through rubble was determined by the depth of excavation and the undisturbed aquifer characteristics. The amount of a radionuclide leached from rubble is determined by the distribution coefficient, the amount of radionuclide present, and this volume of flow. For the canal channel, the initial concentration of any radionuclide in groundwater which flows through excavation rubble into the canal varies by no more than a factor of 3 anywhere along the canal. Total amount of radionuclides which enter per unit length along the channel, however, varies by a factor of nearly 40. Drop in concentration of radionuclide in the groundwater outflow due to leaching removal is very slow. Due to both leaching removal and decay, the level of tritium concentration is reduced by only a factor of 10 in 100 years. (L.C.L.)

11633 (BNWL-715(Pt.4)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1967 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 4. EARTH SCIENCES. Foster, R. F.; (and others) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 60p. Dep. CFSTI.

Thirteen papers on earth science studies in the fields of geology, geophysics, hydrology, and seismology are presented. A separate abstract was prepared for each. (L.C.L.)

For abstracts of individual sections see: 11634–11644 and 11687.

11634 (BNWL-715(Pt.4), pp 1-2) LANDSLIDES IN THE PASCO BASIN, THEIR CAUSES AND SIGNIFICANCE. Brown, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Landslides in the Pasco River Basin were studied to determine their origins. Contrary to the traditional theory that earthquakes are the primary cause of landslides, the importance of soil moisture and floods and irrigation activities in inducing sliding is emphasized. It is concluded that specific reasons for sliding must be determined by a careful study of the soil development and climatic conditions of a region as well as its earthquake history. (L.C.L.)

11635 (BNWL-715(Pt.4), pp 2-4) INDICATED LOW RATES OF TECTONIC DEFORMATION AND THE LOW-SEISMIC ACTIVITY IN THE PASCO BASIN. Brown, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The rates and time of deformation of basalt formations in the Pasco Basin were studied to determine the seismic history of the region. The evidence uniformly suggests low rates of tectonic deformation which, coupled with the absence of surface faults and earthquake-caused landslides, indicate a minimal past significant seismic history. (L.C.L.)

11636 (BNWL-715(Pt.4), pp 5-8) GEOPHYSICAL EVALUATION OF A THICK BASALT SEQUENCE IN SOUTHCENTRAL WASHINGTON. Raymond, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A deep stratigraphic test well—Rattlesnake Hills Number One—was drilled during 1957 and 1958. The 10,655 ft deep well is located in Section 15, Township 11N, Range 24E in Benton County, State of Washington. The objective of the drilling was to penetrate the thick Columbia River basalt and interbed series near the Columbia Basin center and near the axis of a major anticlinal ridge (Rattlesnake Hills). Knowledge of rock types and structure underlying the basalt would be expected to determine the feasibility of further petroleum exploration, but the basalt was not penetrated at the completed well depth. Since the basalt series itself was of secondary interest, only cursory studies and examinations of the rocks were made: ditch sample visual examination, standard "E" log, dipmeter log, gamma and neutron logs, and some vertical and side-hole coring. Reopening of the well has allowed a much more thorough study of all aspects of the rocks in this deep and significant section. (auth)

11637 (BNWL-715(Pt.4), pp 8-12) PALYNOLOGY AND ITS PALEOECOLOGICAL APPLICATION IN THE PASCO BASIN. Tillson, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The Pasco Basin, with its essentially undisturbed ecology, was studied to compare the currently present airborne pollen and spores with pollen fossils which are present in materials interbedded between the more than 90 basalt lava flows geologically characteristic of the area. Each layer of interbed material is, in effect, a confined paleoecosystem, and by studying these plus the present ecology, evolutionary rates in geology, climatology, plant physiology, and ecology over extremely long periods of time can be determined. (L.C.L.)

11638 (BNWL-715(Pt.4), pp 13-17) REGIONAL STRATIGRAPHIC RELATIONSHIP OF THE BASALT FLOWS BENEATH THE PASCO BASIN AS INFERRED FROM GROSS CHEMICAL VARIATIONS. Tillson, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Working on the assumption that gross chemical homogeneity exists in a group or series of basalt flows related in source, time, environment, or combinations thereof, the gross chemical compositions of the basalt flows beneath the Pasco Basin were determined by spectrochemical analysis. First, ditch samples from Rattlesnake Hills Well No. 1 in the Pasco Basin were analyzed which indicated five major changes in chemical homogeneity at depths corresponding to 1600, 2600, 7700, 8400, and 9500 ft. Side-wall core samples were then spectrochemically analyzed and showed chemically homogeneous regions at depths of 1700, 2700, 4300, 7700, and 8600 ft. Finally, logs of various physical measurements indicated that four discrete depths exist where changes in the log characteristics could be observed visually. A composite of the three methods indicates that gross physical or chemical changes occur in the proximity of 1600, 2600, 4200, 7700, 8500, and 9500 ft depths. A diagram representing a regional stratigraphic section based on these data is presented. (L.C.L.)

11639 (BNWL-715(Pt.4), pp 17-22) GAMMA-RAY ATTENUATION FOR SOIL WATER CONTENT MEASUREMENTS USING ^{241}Am. King, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The laboratory measurement of moisture content of soil samples by the attenuation of gamma rays is described with particular reference to the use of ^{241}Am as a source of photons. The ^{241}Am is compared with ^{137}Cs, and some advantages and disadvantages of each are pointed out. The major advantages of ^{241}Am over ^{137}Cs are that less biological shielding is required; the apparatus may be made smaller and lighter; there is greater sensitivity for small soil thicknesses (4.5 to 6 cm). Disadvantages of ^{241}Am are that special preamplification of the 60 keV signal is needed and that it is limited in application to small samples because of the soft gamma rays emitted. Laboratory results are presented showing the comparison of soil water content measured volumetrically with the content determined by attenuation of gamma rays from ^{241}Am. The sample was contained in a small cell where the moisture content was controlled by controlling the capillary pressure. The water was extracted through a saturated porous material and measured in a calibrated horizontal tube. Even with the rather poor agreement of these preliminary results, it is believed that the use of ^{241}Am in a properly designed apparatus will yield good measurements of soil moisture content. (auth)

11640 (BNWL–715(Pt.4), pp 22-5) INVESTIGATION OF ELECTRICAL RESISTIVITY METHODS FOR DETERMINING THE IN-PLACE MOISTURE CONTENT OF RELATIVELY DEEP SOIL ZONES. Peterson, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An attempt was made to determine the in-place moisture content of relatively deep soil zones, such as those beneath liquid radioactive waste disposal sites, by measuring the electrical resistance between electrodes driven into the ground surface. The means of supplying voltage and of measuring the current, which is a function of the resistivity of the soil at a depth equal to the horizontal spacing between electrodes, is described. The results indicated that the method will discriminate between moist and relatively dry soils, but it is not practical for delineating capillary fronts at increased depths. Therefore, the resistivity traverse method was not considered a practical substitute for depth moisture determinations by drilling. (L.C.L.)

11641 (BNWL–715(Pt.4), pp 25-9) COMPARISON OF THE TRADITIONAL AND ENERGY DISSIPATION METHODS FOR PERMEABILITY DETERMINATION. Cearlock, D. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An accurate knowledge of the permeability distribution in soils is necessary for accurately predicting changes in ground water flow systems. The traditional method used in determining permeability of a flow system is based on extrapolation of data from pumping tests, well logging, and other geologic data and its accuracy depends on the amount of data and extent of extrapolation. The energy dissipation method involves measuring the distribution of ground water potential for the existing saturated ground water flow system, then theoretically reducing the tabular potential data to a potential function, and finally, by using a computer program such as STREAM, analyzing the potential function to determine how the energy is dissipated in the flow system. Both methods were used to calculate the permeability distribution over part of the Hanford ground water flow system and yielded dissimilar results. The actual potentials for the area were then measured and compared with the potentials calculated by each method. The energy dissipation method was found to be considerably more accurate in determining permeability distribution. (L.C.L.)

11642 (BNWL–715(Pt.4), pp 29-30) IMPROVED GENORO DATA FITTING ROUTINE FOR APPLICATION IN HYDROLOGICAL ANALYSIS. Reisenauer, A. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An improved double precision version of the GENORO computer code permits the determination of a fitting function for a given set of data points, the evaluation of that function, or the evaluation of any function of the proper form on a grid or at random points. The data points may be any N arbitrary points in a D-dimensional space. Several functional types are available. (auth)

11643 (BNWL–715(Pt.4), pp 30-4) FUNEVAL: A ROUTINE FOR BLENDING SURFACE FUNCTIONS. Cearlock, D. B.; Friedrichs, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The FUNEVAL computer program, used in developing the blended surface concept for analytically describing ground water potential distributions, i.e., accurately modeling ground water flow systems, is described. (L.C.L.)

11644 (BNWL–715(Pt.4), pp 42-9) ZEOLITE AMMONIUM ION CAPACITY IN MIXED CATION EQUILIBRIUM SYSTEMS. Ames, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A method for determining the zeolite cation equilibrium capacities through their binary selectivities in mixed cation solutions was tested. Ammonium ion selectivities in a solution containing sodium, potassium, calcium, magnesium, and ammonium ions were predicted from the binary equilibrium data with good results. The method was found to be useful for prediction of the equilibrium capacity for any number and ratio of cations, providing the relevant equilibrium data are available. (R.C.K.)

11645 (BNWL–715(Pt.4), pp 50-6) TRACE STRONTIUM ADSORPTION IN A PARTIALLY SATURATED TRANSIENT SYSTEM. Hajek, B. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The results of a study on the movement of trace quantities of strontium in a sodium solution invading dry soil are presented. (L.C.L.)

11646 (COO–1264-5) FATE OF ZINC IN NATURAL SURFACE WATERS. Final Report. Civil Engineering Studies; Sanitary Engineering Series No. 49. O'Connor, John T. (Illinois Univ., Urbana. Dept. of Civil Engineering). Oct. 1968. Contract AT(11-1)-1264. 164p. Dep. CFSTI.

The fate of zinc in natural waters was studied. The studies began in 1962 with a survey of analytical techniques for the separation and analysis of zinc and cobalt in environmental samples of water, bottom sediments, and plankton. Samples of water, plankton, and bottom sediments were obtained from the Columbia River over a reach of approximately 100 miles extending from just upstream of the Hanford reactors downstream to the function of the Umatilla River. Studies were also conducted on zinc adsorption by sediments in a saline environment, fate of zinc in small streams, effects of organic materials, phosphates, time, and algae on zinc adsorption, and effects of reducing conditions on zinc adsorption. It was concluded that if continuous water monitoring and automatic by-pass systems are maintained, the occurrence of ^{65}Zr and ^{60}Co in their present concentrations in Columbia River water, plankton, and bottom sediments is very unlikely to produce a significant radiation exposure hazard to the people using the river as a source of drinking water. (R.C.K.)

11647 (ISO–668) STUDY OF LAND REQUIREMENTS. Progress Report. Sloat, R. J. (Isochem Inc., Richland, Wash.). Jan. 16, 1967. Contract AT(45-1)-1851. 27p. Dep. CFSTI.

Progress on studies is summarized on the land requirements of Battelle Northwest, Hanford Occupational Health Foundation and Isochem. Criteria were developed including land requirements for present normal plant operation, nuisance contamination and minor incidents, and major accidents. In normal plant operation iodine stack release dictates land requirements. A composite map was designed which shows overall land requirements dictated by all possible major accidents in the plants or in transport between plant areas. Studies will be initiated on land which will be releasable with restrictions, research and development needed to reduce retained land, and the effects of new facilities installed and operated close to Hanford Separations facilities might have upon land requirements. (F.S.)

11648 SOME PROBLEMS OF THE GEOCHEMISTRY OF THE STRONTIUM ISOTOPES. Gorokhov, I. M. Sov. Geol., No. 2, 89-101(1968). (In Russian).

Strontium in subsialic sources can be distinguished from strontium in sialic rocks on the basis of their isotopic composition: thus the ^{87}Sr : ^{86}Sr ratio can be used as an indicator of geologic processes. Volcanic rocks, volcanic detrital sediments, and volcanic emanations originating in the mantle have ^{87}Sr : ^{86}Sr ratios that vary within narrow limits, averaging 0.704 ± 0.002. Strontium bearing silicates in continental rocks are enriched in ^{87}Sr. The isotopic composition of strontium in carbonates and sulfates of marine origin is an indication of the isotopic composition of oceanic strontium at the time of their formation. (Geophys. Abstr.)

11649 RADIOACTIVITY TRANSPORT IN WATER: SIMULATION OF SUSTAINED RELEASES TO SELECTED RIVER ENVIRONMENTS. Shull, Roger Don. Austin, Tex., Univ. of Texas, 1968. 254p.

Thesis.

The transport of radionuclides in rivers was simulated with a mathematical model. Large unregulated rivers receiving continuous normal waste discharges were studied with the model. The model included stochastic temporal flow variation, deterministic longitudinal flow variation, three-dimensional channel geometry variation with time and distance, generalized boundary sorption, boundary erosion, and flooding. Rivers of erratic flow, gradually varying flow, and nonvarying flow were studied. Hydrologic statistical variations in the system were examined. Effects of variations in radioactive half-life, surface concentration distribution coefficient, mass transfer coefficient, and sorption reversibility were also investigated. Variations in the mass transfer coefficient were not significant, but variations in surface concentration distribution coefficients were influential. On a long-term basis, flow variability had a significant effect on transport of short-lived radionuclides. Studies on continuous sedimentation zones indicated that significant quantities of long-lived radionuclides may accumulate therein. (Disser. Abstr.)

11650 SORPTION AND RELEASE OF ^{89}Sr AND ^{137}Cs BY RECENT SEDIMENTS OF THE GUADALUPE RIVER OF TEXAS. Clanton, Uel S. Jr. Austin, Tex., Univ. of Texas, 1968. 96p.

Thesis.

Experiments were performed to determine the rates of ^{137}Cs and ^{89}Sr sorption and release in recent sediment samples from the Guadalupe River drainage basin in Texas. The samples were analyzed for their mineral composition, ion exchange capacity, and radionuclide sorption. Rates of radionuclide sorption and release were highest during the first few moments of contact, but totals slowly continued to increase throughout the seven-day duration of the experiments. Sediments containing the naturally occurring organic fraction had the highest sorption values both for ^{89}Sr and ^{137}Cs. The organic fraction contributes to the overall sorption capacity of the sediments, even though some of the organic molecules may block exchange sites on the clay minerals against exchange with the radionuclide. These laboratory experiments indicated that radionuclide sorption in the dynamic fluvial environment was temporary. When the contaminated sediments were placed in conditions simulating a marine environment, 43% of the ^{137}Cs and 42% of the ^{89}Sr were released because of competition for the exchange sites from the more abundant ions in seawater. Even though fluvial releases are considered an acceptable means of radionuclide disposal, it should be emphasized that all stream systems are dynamic, and this disposal is at best temporary. The brief respite gained today may be overshadowed by the ultimate contamination of tomorrow. (TSS) (Disser. Abstr.)

11651 DETERMINATION OF THE VELOCITY OF GROUNDWATER FLOW WITH RADIOISOTOPES. Hazzaa, I. B. (Middle Eastern Regional Radioisotope Center, Cairo). Int. J. Appl. Radiat. Isotop., 20: 127-9(Feb. 1969).

The velocity of groundwater flow can be calculated if the displacement r during a period t is known (v = r/t), and it is possible to measure r by introducing a radioisotope into a well, allowing the radioactivity to be carried away by the groundwater stream over a known time and then pumping from the well at a known rate, the radioactivity in the pumped water being continuously monitored. Several ways of applying this method are described, including tests of the method using a model basin (UK)

11652 EFFECT OF METEORITIC ALTERATION ON THE TRACE URANIUM IN THE TWO-MICA GRANITE OF THE ST. SYLVESTRE MASSIF. Barbier, J.; Ranchin, G. (Centre de Recherches Radiogeologiques, Nancy). Geochim. Cosmochim. Acta, 33: 39-47(Jan. 1969). (In French).

In the two-mica granite of the St-Sylvestre massif, the transition from fresh rock at depth to the zone of surface weathering is marked by the destruction of uraninite which contains about half of the total uranium in the rock. In general, a considerable portion of the uranium (65 to 70%) is mobilized. In the lower part of the weathered zone, even though the chemical alteration effects on the rock are weak and practically limited to a partial oxidation of ferrous iron, the uranium released precipitates as autunite along cracks; but for sample sizes in the kilogram range, the uranium content does not change. In the upper part of the zone of weathering, where the chemical alteration effects are stronger, the autunite itself is dissociated and the uranium is again released. A fraction of the uranium is removed from the surface zone and, as a result, the average content of the surface samples is appreciably less than the average content of the unaltered rock at depth (14 to 22 γ). Some uranium is also redistributed in a disseminated form on the adsorptive surfaces of alteration products, so that, locally, the uranium content changes little, though it sometimes increases. In this type of granite the distribution of the uranium in near surface rocks is essentially determined by all the processes of the weathering cycle. This results in a geochemical distribution of uranium which is very different from that encountered in unaltered rocks at depth. (auth)

11653 TRANSPORT OF ORGANIC AND RADIOACTIVE WASTES. Armstrong, Neal E.; Canter, Larry W.; Gloyna, Earnest F. (Engineering Science, Inc., Oakland, Calif.). Contract AT(11-1)-490. Water Wastes Eng., 5: 54-6(July 1968).

Factors that affect the transport of radioactive wastes in a model river are described. The design of the model river system, its instrumentation, and its uses are described in detail. The ground water supply, depth control, and aquatic life environment are itemized. The instruments installed measure several environmental factors, such as pH, dissolved O, temperature, sunlight, and oxidation-reduction potential. To measure sunlight energy, 2 pyrheliometers were used ~ midway between the inlet and outlet. The digital data acquisition system and its operation are described briefly. The dispersions of 8 radionuclide tracers at various velocities, water depths, and bed slopes were studied to determine how their transport is affected by environmental conditions. The dispersion of ^{51}Cr(III) is illustrated. The approximately Gaussian curves at each station indicated typical dispersion, but the long tails were the result of uptake and subsequent release of radioactivity by sediments and plants showing the effects of one environmental condition on radionuclide transport and also indicating the importance of geochemical and biochemical relations in transport. The effect of organic pollution on sediment uptake of ^{51}Cr(VI) is shown. On the control side of the model river, where no organic load was added, the percentage rise in the sediment was only moderate, whereas, on the polluted side, the rise was rapid to a level ~3 times that of the control side, because of ^{51}Cr sorbing onto settling particles. Sediment transport and its role in radionuclide transport is being considered now for study in the model river. Mathematical models are being developed to describe and predict radionuclide transport and the manner in which it is affected by environmental conditions. (BBB)

Meteorology

Refer also to abstracts 11443, 11444, 12070, and 13278.

11654 (NYO-3673-3) RESEARCH PROJECT: TRANSVERSE JET PLUMES. Progress Report, December 1, 1967–December 31, 1968. Halitsky, James; Kaplin, Edward J. (New York Univ., N. Y. Geophysical Sciences Lab.). Contract AT(30-1)-3673. 35p. (GSL-TR-68-13). Dep. CFSTI.

A description of equipment and procedures developed for sampling and analyzing plume concentrations for both atmospheric- and wind tunnel-release conditions is presented. (L.C.L.)

11655 (SC-RR-68-555) DIFOUT: A MODEL FOR COMPUTATION OF AEROSOL TRANSPORT AND DIFFUSION IN THE ATMOSPHERE. Luna, R. E.; Church, H. W. (Sandia Labs., Albuquerque, N. Mex.). Jan. 1969. 67p. Dep. CFSTI.

The theory and use of DIFOUT, a computer-programmed model for prediction of transport and diffusion of aerosol clouds, is explained. An illustrative problem is worked to display the scope of inputs the model will accept. (auth)

11656 (SWRHL-17-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE KIWI TNT EXPERIMENT. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Aug. 6, 1965. 20p. Dep. CFSTI.

Off-site radiation surveillance provided in support of the Kiwi Transient Nuclear Test (TNT) conducted on January 12, 1965 is described. This support consisted of tracking the effluent, monitoring radiation dosage to the off-site population and collecting environmental samples in southern Nevada and California. Although off-site contamination occurred as a result of Kiwi TNT, the data collected indicate that radioactivity levels did not exceed Radiation Protection Guides established by the Atomic Energy Commission for the off-site population. (auth)

11657 PARTICLE SIZE AND MEAN CONCENTRATION OF RADIOACTIVE AEROSOLS MEASURED BY PERSONAL AND STATIC AIR SAMPLES. Stevens, D. C. (Atomic Energy Research Establishment, Harwell, Eng.). Ann. Occup. Hyg., 12: 33-40(Jan. 1969).

Cascade centripeters and personal air samplers were used for a period of one year to measure the particle size of radioactive aerosols in various buildings at A.E.R.E. Harwell, and to examine the relationship between personal exposure and exposure measured by an environmental (static) sampler. The particle size distribution of the airborne activity in all buildings was approximately log-normal. In the incinerator building and filter house the activity median aerodynamic particle diameter was 5 to 6 μm for both α and β activity, with a geometric standard deviation of 2.5 to 3.0. Similar size distributions were obtained for β activity in the high-activity handling building and in the wet decontamination area, but airborne α activity in the latter had a median diameter of 3.5 μm with a geometric standard deviation of 4.3. The air concentrations measured by samplers operating on a weekly basis were statistically analyzed, and the convenience of the log-normal distribution is demonstrated. It is shown that in areas where the source of airborne contamination is widespread and not directly associated with particular operations, the long-term mean exposure indicated by personal samplers is similar (within a factor of 2 or 3) to that indicated by the static (centripeter) sampler. In an area such as the decontamination area, however, where each man generates a localized aerosol, the mean exposure indicated by personal samplers is often 10 or more times higher than that shown by a static sampler. (auth)

11658 AIRBORNE RADIONUCLIDES AND PLANTS. Menzel, Ronald G. (Soils Lab., Beltsville, Md.). Publ. Amer. Ass. Advan. Sci., 85: 57-75(1967).

Current information on the factors governing the deposition of radioactive materials from the air and their retention by plants is discussed. The nature of airborne radionuclides and mechanisms for their deposition on plants and removal from plants are described. Finally, the effects of various levels of contamination on plants are discussed. Rainfall is very important in the deposition and removal of radioactive particles from plants. The dominating mechanisms for dry deposition are gravitational settling (for large particles) and eddy turbulence and diffusion (for gases). (Meteorol. Geoastrophys. Abstr.)

11659 PROCEEDINGS OF THE THIRD NATIONAL CONFERENCE ON AEROSPACE METEOROLOGY, MAY 6–9, 1968, NEW ORLEANS, LOUISIANA. Boston, Mass., American Meteorological Soceity, 1968. 579p. (CONF-680534).

Separate abstracts were prepared for two of the seventy-two papers presented. The remaining papers were not within the scope of NSA. (B.G.D.)

For abstracts of individual papers see: 11892 and 12664.

11660 VERTICAL DISTRIBUTION OF NATURAL RADIOACTIVITY IN THE FREE ATMOSPHERE IN THE PRESENCE OF CLOUDINESS IN THE MIDDLE STRATUM. Styro, B. I.; Chkhenkeli, Sh. M.; Tavartkiladze, K. A.; Khindzhua, T. G. Soobshch. Akad. Nauk Gruz. SSR, 49: 65-8(1968). (In Russian).

The regularities of distribution of natural radioactivity in the free atmosphere in the presence of clouds in the middle stratum and low wind velocity near the ground were established experimentally, using data from 10 flights made in the second half of 1966. From the vertical profile thus obtained, turbulent diffusion is estimated. (Geophys. Abstr.)

11661 ^{239} ^{238}Pu, ^{90}Sr, AND ^{137}Cs IN SURFACE AIR FROM MID 1961 THROUGH 1965. de Bortoli, M. (EURATOM, Ispra, Italy); Gaglione, P.; Malvicini, A.; Van der Stricht, E. pp 361-7 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

Monthly air concentration values, at ground level, of some long lived radionuclides (strontium-90, cesium-137, plutonium-239 and plutonium-238) from worldwide fallout were measured at Ispra, from mid 1961 through 1965. Samples of atmospheric debris were collected by filtering 6 to 8 thousand cubic meters of air through paper filters. The single radionuclides were determined by analytical procedures, which are briefly described. Particularly, for plutonium a simple and rapid radiochemical method was developed, in order to obtain electrodeposited samples, suitable for alpha spectrometry. This was performed by Frisch-grid ionization chamber and multichannel analyzer. Plutonium-239, strontium-90 and cesium-137 concentrations show, during the five years considered, the well known trend of fallout, characterized by the spring maxima. Plutonium-238 seems to behave rather particularly and to follow less closely this trend. Fairly constant values of the ratios ^{137}Cs/^{90}Sr and ^{239}Pu/^{90}Sr are found, whereas the ^{238}Pu/^{239}Pu ratio varies by a factor ten or more and shows two strong fall peaks in 1961 and 1962, i.e., in the periods of heavy nuclear testing in the atmosphere. The highest concentrations, found during the summer of 1963, attained the values of 1.8×10^{-3} pCi/m^3 for plutonium-239, 3.5×10^{-5} pCi/m^3 for plutonium-238, 9.6×10^{-2} pCi/m^3 for strontium-90 and 0.14 pCi/m^3 for cesium-137, respectively. Some considerations were made about inhalation doses to the population at large. It appears that a significant fraction of the MPC may have been attained, at least for a part of the period considered, particularly for strontium-90 and plutonium-239. Concerning the latter radionuclide, some uncertainty stems from the lack of knowledge of the extent to which it is in soluble form. If most of the plutonium-239 present in airborne debris has to be considered soluble, then the maximum concentration observed would represent 0.3% of the MPC for occupational exposure for a 168 hr week. (auth)

11662 ENERGY DISTRIBUTION OF GAMMA RADIATION OF A RADIOACTIVE CLOUD. Schmidt, A.; Wensel, A. (Institut fuer Kernphysik, Frankfurt am Main). pp 265-9 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

The energy distribution of the γ radiation of a radioactive cloud was calculated with Monte Carlo methods and experimentally determined. A homogeneous infinite expanding air or water volume was used as the scattering medium. Scattering spectra of point γ sources were calculated in dependence on the distance from the source point. By integration, the scattering spectra of the γ radiation of radioactive clouds of various geometries were determined and the corresponding dose distributions were obtained by additional integrations. With a second Monte Carlo program the scattering spectra and dose distributions of the γ radiation of a radioactive cloud were calculated directly. Scattering spectra of the γ radiation of radioactive clouds were measured in the water tank installation of the Institute for Nuclear Physics, Frankfurt/Main. The clouds were simulated by a plastic sack filled with radioactive solution. The sacks were arranged at various distances from the detector. The energy distributions were determined from the pulse height distributions of a NaI(Tl) scintillation counter with matrix inversion. The measured values were compared with the calculated spectra and dose distributions. There was satisfactory agreement between these and with dose values from the literature. The results were discussed in reference to the radiation burden of the population in the vicinity of a nuclear installation in which the release of radioactive substances is possible. (tr-auth)

Mineralogy and Exploration

11663 (GJO-115-1) RESOURCE EVALUATION AND GEOLOGIC DATA PROCESSING SYSTEMS FOR SEDIMENTARY HOST ROCKS OF URANIUM ORE. Final Report. Bostick, N. H.; Lange, A. L.; Farquhar, R. P. (Stanford Research Inst., Menlo Park, Calif.). Sept. 25, 1968. Contract AT(04-3)-115. 382p. Dep. CFSTI.

The increased use of uranium for power-reactor fuel necessitates long-term evaluation of uranium resources. To accomplish this, ways in which the necessary geological information could be compiled and evaluated, using electronic data processing was investigated. Design criteria for a general geologic data system were worked out, and the complex computer programming for location, structural, and stratigraphic data was completed and tested. The above research revealed that, even with electronic data processing, use of a general geologic data system for resource evaluation would require a large data input program and funding far beyond the scope of this present project. Thus, a special system for uranium resource evaluation was designed and tested; this system provides, with fairly simple and rapid data input, prediction of favorable uranium host rock location and volume, and this output correlates well with known uranium production in a test area. The special RESOURCE system could give the required evaluation for North America with about 1,000 man-days of data acquisition effort. (auth)

11664 THE MINING ACTIVITIES GROUP AT CNEN. Com. Naz. Energ. Nucl., Notiz., 14: No. 11, 58-71(Nov. 1968). (In Italian).

Mining exploration activities and laboratory and pilot-plant studies of the most effective processing methods at CNEN are discussed. Mining activities at Clusone, seismic statistics, and ore preparation are described. (auth)

11665 NUCLEAR POWER AND URANIUM RESERVES. Faulkner, Rafford L. (Atomic Energy Commission, Washington, D. C.). S. Afr. Mining Eng. J., 79: 86-8; 90; 92(June 14, 1968).

Annual U_3O_8 requirements through 1980 for both the U.S. and for the non-Communist world are discussed. Annual requirements will continue to increase well into the 1980's notwithstanding the expected introduction of breeder reactors in the early or middle 1980's. The AEC median forecast of 145,000 MW(e) by 1980 is extrapolated to 255,000 MW(e) in 1985. The annual rate of U_3O_8 requirements in 1985 would be 50,000 tons or more. Reasonably assured reserves at various prices and estimated additional quantities are estimated. Exploration continues at a high rate in 1968. Prior estimates for development and exploratory drilling in 1968 of 14 million ft will be exceeded. In recent years, a little over 3 lb U_3O_8 has been discovered per foot of drilling. However, from 1960 to 1965 the average depth of holes drilled from the surface was 160 ft, increasing to 220 ft in 1966 and to 360 ft in 1967. Because of the current importance of adequate ore reserve data to both producers and consumers of nuclear fuel, significant gaps in the information gathered by the AEC on reserve statistics should not develop. Reserves estimated at the beginning of 1968 had increased by 7,000 tons U_3O_8 over 1967 after allowing for the mining of about 11,000 tons of reserves. Industry plans to lease from AEC the equivalent of about 8,000 tons of U_3O_8, of which about half may still be on lease 30 June 1973. Lead times for planning initial commercial operation average 23.5 months. For reloads, lead times average 15.5. Most companies plan to recycle U from discharged fuel elements, but plans for Pu are generally less definite. The average price estimates of all respondents, including buyers and sellers, increased annually from around $7.10 a lb of U_3O_8 for 1970 delivery to $7.80 for 1973 delivery. (BBB)

11666 THORIUM, RADIUM, AND POTASSIUM IN MANGANESE NODULES. Buchowiecki, J.; Cherry, R. D. (Univ. of Cape Town, Rondebosch, S. Afr.). Chem. Geol., 3: 111-17(June 1968).

The origin and composition of the so-called manganese nodules, found over large areas of the ocean floors, are considered. Twenty-three determinations of Th in manganese nodules have been reported previously, but since these determinations were made by different techniques and by 5 different research groups, the data were extended by Th determinations in 20 nodules. Thorium determinations were made by the γ-spectrometric technique, and Ra and K values are presented as a by-product. The Th data are combined with Th determinations of various earlier workers to give a histogram showing a clear mode in the vicinity of 22 ppM Th, with slight evidence for a second group of nodules with a higher modal Th value at ~65 ppM. No distinct correlation between Th and Co values was observed, nor was there any definite evidence for ocean-to-ocean variations in the Th contents. (BBB)

11667 EXPANDING URANIUM AND GOLD PROSPECTS OF ANGLO AMERICAN GROUP. **S. Afr. Mining Eng. J., 79: 1376-7(May 31, 1968).**

Promising Au and U values were disclosed by the prospecting program in the southern portion of President Steyn and President Brand. The siting of a new shaft at President Brand is being reconsidered and sinking operations have been suspended. In the United States, Europe, Japan, and in less highly industrialized countries, developments have strengthened the immediate and long-term demand for U, enabling the South African industry to conclude new contracts and to plan for expansion. A U plant is to be built at Western Deep Levels. The Vaal Reefs U plant has been re-commissioned, and the new prospect, Vaal Reefs South, is also to produce U. Mining reports for diamonds, Cu, coal, Ni, Fe, Pb, Zn, and pot ash are also summarized. (BBB)

11668 URANIUM AND RARE EARTH METALS. **Mining J. (London), 271: 40-1(July 19, 1968).**

The U treatment works at Port Pirie ceased production in 1962. Two companies of Sydney have merged in order to process U oxide and rare earth oxides. The site includes 10 acres of buildings and equipment and 70 acres residue dams left over from previous operations. These dams contain the world's largest known supplies of Sc. U oxide will be extracted from the residue. The main source of U and rare earth metals will be monazite. Full-scale production is expected to start in September 1968. (BBB)

11669 STUDY OF SOME RADIOACTIVITY OF PEGMATITES. VanWambeke, L. **Bull. Soc. Belge Geol. Paleontol. Hydrol., 76: 7-26(1968). (In French).**

Uranium and more rarely thorium minerals occur in the sodalithic pegmatites of Buranga (Rwanda) and of Mapembe and Liha (Congo-Kinshasa). Radioactivity is generally concentrated in minerals of the microlite series but also in uranothorogummite and zircon euxenite, tantalpolycrase, and tanteuxenite. Columbotantalites sometimes have a low content of radioactive elements. This study shows that during the soda-lithic pegmatitic differentiation, which is characterized by a gradual increase of the $Ta_2O_5 : Nb_2O_5$ ratio of the columbotantalates, the residual solutions become impoverished in radioactive elements, and as a result the microlites of the last generation, which have the highest content of Ta, are often devoid of radioactivity. (Geophys. Abstr.)

11670 PILOT-SCALE EXPERIMENTS ON THE HYDROMETALLURGIC MINERAL PROCESS FOR THE MALARGUE CUPRO-URANIFEROUS DISTRICT. **Garcia Bourg, J. M.; Costarelli, R.; Obermann, R. A. (Comision Nacional de Energia Atomica, Buenos Aires). Ind. Quim. (Buenos Aires), 26: 42-5 (1968). (In Spanish).**

After adoption of the final flowsheet for the processing of the Malargue Cu-U ore, pilot plant scale experiments were performed. Advantages and disadvantages in the performance of the flow sheet steps at pilot plant scale are discussed. Only the steps of milling, flotation, roasting, and acid leaching were tested. Reagent consumption at the last step was studied in detail because of its strong incidence in the economics of the overall process. Pilot plant scale experiments on acid leaching of U from the Malargue ore are described. An operations diagram of the different steps required for pilot-plant performance is presented. As a result of these studies it was possible to predict the behavior of the ore, facilitating the design of the Malargue Plant. After the Malargue mill was built and put into operation with a treatment capacity of more than 100 tons per day, predictions from pilot plants were confirmed in actual production scale. (BBB)

11671 DETERMINATION OF THE CONCENTRATION OF THE "FREE" COMPONENT OF RaA IN THE ATMOSPHERE OF A URANIUM MINE. Serdyukova, A. S.; Savenko, E. I. Izv. Vyssh. Ucheb. Zaved., Beol. Razved., No. 2, 100-6(1968). (In Russian).

Radon decay products in uranium mines consist mainly of ^{218}Po (RaA). Qualitatively the "free" component of ^{218}Po varies from 8 to 30 percent in units of radon equilibrium, or from 12 to 97 percent in fractions of the total ^{218}Po content, depending on the operating conditions. The concentration of "free" ^{218}Po decreases as the number of condensation nuclei (aerosol particles) increases. The lack of data on the fundamental dimensions of the aerosol particles absorbing the short-lived products of radon decay, and on the concentration of particles in different conditions, at present precludes the theoretical calculation of the amount of ^{218}Po. (Geophys. Abstr.)

11672 UNITED STATES: THE TOTAL ENERGY PICTURE THROUGH 1985. **Mining J. (London), 271: 38-9(July 19, 1968).**

Projections of the total energy use by category of fuel are given. Nuclear energy, which at the moment is almost insignificant, should have 6% of the market in 1975 and about 17% in 1985. For the electrical power market, the rapid growth of nuclear power will hold coal to a figure of about 20% above the 1965 level. These estimates for nuclear fuel for 1975 are based on nuclear plants already installed or ordered plus an additional amount of capacity which is now in the planning stage. By 1975 total installed capacity in the U. S. is expected to be 70,000 MW of which 62,000 is now firm. Nuclear power is at present competitive with coal and, with the savings in the fuel cycle yet to be realized, it should be even more competitive in the future. The fuels for which adequate supply may be a problem in North America are liquid petroleum, natural gas, and U ore. However, U is comparatively easily shipped and its competitive position will probably rest on the international market. (BBB)

11673 GENERAL SITUATION OF NEW METAL INDUSTRY IN JAPAN IN 1968: NUCLEAR FUEL. **Ikematsu, Masamori** Shin Kinzoku, No. 49, 3-6(Sept. 1968). **(In Japanese).**

Nuclear power generation will reach 1.3 million KW in 1970 according to programs of electrical enterprises. In 1985 a quarter of all generating facilities will be nuclear powered. The required amount of nuclear fuels will be about 500 tons in 1975, and showed increase to 2000 tons in 1985. In the long term program, it was decided to secure the low priced stable supply of natural uranium, to obtain enriched uranium, to fully equip for the production of nuclear fuel and reprocessing of used fuel, to establish the technique for utilizing plutonium in thermal neutron reactors, and to survey production techniques for enriched uranium for domestic production. The supply and demand relation of uranium in the world the basic price of enriched uranium, and the reprocessing methods for used fuel are described. The amount of nuclear fuel retained in Japan at the end of 1967 is shown. (NSA of Japan)

11674 A.A.C'S PART IN URANIUM INDUSTRY. **S. Afr. Mining Eng. J., 78: 2261-3(Sept. 22, 1967).**

In 1945 Anglo American's Western Reefs gold mine played an important part in the establishment of the U industry in South Africa. The methods of U recovery developed at Western Reefs' pilot leach plant formed the basis of the extraction process used by the commercial producers. In this process U extraction can be divided into the same basic 3 stages as Au recovery; namely, dissolution, separation of the solution containing U from the remaining solids, and recovery of U from this solution. In U recovery, H_2SO_4 solution is used and acid-resisting materials are necessary in construction of processing equipment. Because some mines have low U grade, it is necessary to concentrate the valuable materials in the cake by means of a flotation process. The leached residue slime remaining from several filtrations is then passed to the flotation plant, where the pyrite is recovered. The solution is passed through a series of columns containing an ion exchange resin. When the resin becomes saturated with U it is removed by passing NH_4NO_3-HNO_3 through the resin. The ammonium diuranate precipitate so formed is partially dewatered and finally dispatched in the form of a yellow slurry. The slurry is calcined to form uranium oxide. Between 1952 and 1958 Anglo American built 5 U plants, 3 flotation plants, and 2 H_2SO_4 plants. Seven of the Corporation's mines were active U producers. (BBB)

Oceanography

Refer also to abstracts 11443, 11444, 11666, and 11915.

11675 SORPTION AND DESORPTION OF RADIONUCLIDES BY SHALLOW-WATER SEDIMENTS OF THE BLACK SEA. **Baranova, D. D.; Polikarpov, G. G. (Inst. of Biology of the Southern Seas, Sevastopol, USSR). Okeanologiya, 8: 427-30(1968). (In Russian).**

From among the sediments studied, the shallow-water muds, aleuritic with mussel biocoenosis and phaseoline, have the greatest sorption ability for ^{90}Sr, ^{95}Zr, ^{106}Ru, ^{137}Cs, and ^{144}Ce. Despite different mechanical properties and chemical composition, these muds have similar concentration factors for each nuclide which is due to the size of the fraction with particle sizes less than 90 μ.

Aleurite mud with mussel biocoenosis and phaseoline mud adsorb ^{91}Y, ^{95}Zr, ^{137}Cs, and ^{144}Ce most effectively. However, ^{90}Sr and ^{106}Ru have no high concentration factors; i.e., they are poorly extracted from sea water. Muds best retain ^{137}Cs, which is appreciably desorbed by sea water and by 0.2$\underline{N}$ HCl. In contrast, ^{90}Sr and ^{106}Ru are readily desorbed by these solutions by 90% and 86.5%, respectively. An increase of the desorption of ^{91}Y and ^{144}Ce by 0.2$\underline{N}$ HCl from the muds studied is correlated with the presence in the latter of carbonic rocks. (BBB)

11676 STUDIES ON THE RELEASE OF RADIOACTIVITIES FROM THE ION EXCHANGE RESINS INTO THE SEA WATER. Nishiwaki, Yasushi (Tokyo Inst. of Tech.); Honda, Yoshihide; Kawai, Hiroshi; Harada, Takeo; Kimura, Yuichiro; Morishima, Hiroshige; Koga, Taeko. pp 681-99 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

For the purpose of estimating the release of radioactivities from ion exchange resins disposed into seawater, a series of experiments was conducted in a water bath containing natural seawater. The radioisotopes ^{51}Cr, ^{55}Fe, ^{60}Co, ^{89}Sr and fission products were used in the experiments by changing the weight ratio of ion exchange resin to the seawater and the amount of nuclide initially adsorbed on the ion exchange resin under static and turbulent conditions. The results are summarized as follows: the radioactivities were rapidly released from the ion exchange resin particles (Dowex 50 and Dowex 1, 50 to 100 mesh) on contact with the seawater. However, some differences were observed in the degree of release depending on the different nuclides. Such nuclides as ^{60}Co and ^{89}Sr were easily released, while ^{51}Cr and ^{55}Fe not so easily; the released activity was observed to increase with the decreasing weight ratio of the ion exchange resin to seawater, but with the weight ratio below 10^{-4} of the ion exchange resin to the seawater no remarkable difference was observed; and the results of fractionation of suspended matter in seawater containing ^{55}Fe, ^{60}Co, and ^{89}Sr were also determined. (auth)

Seismology

Refer also to abstract 11635.

11677 (UCRL-50480) MOTIONS OF EARTH FILL DAMS DURING THE GASBUGGY EVENT. Power, Dean V. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 30p. Dep. CFSTI.

Measurements of motions were made on and near the Navajo and the El Vado Dams during the Gasbuggy detonation. These dams were 38 and 43 km, respectively, from the center of the detonation. The response of these earth-filled dams to the seismic motions from the Gasbuggy Event were analyzed in both the time (velocity) and frequency (power spectral density) domains. Amplification of ground motions were found to be dependent upon frequency and location. Resultant peak particle velocity amplitudes on the crest were found to be 2.1 times the base motion on the Navajo Dam and 2.7 times the base motion on the El Vado Dam. Peak power spectral densities were found to range from 3 or 4 times base motion to as much as 40 times base motion at the dam's resonant frequencies. Correlations of power spectral densities for different stations resulted in a determination of the frequencies for the first few natural modes. Shear wave velocities of about 1100 ft/sec in the fill material were calculated using these frequencies and a simple mechanical model of the dams. (auth)

11678 EFFECT OF A FAULT ON EXPLOSION-GENERATED GROUND SHOCK SPECTRA. **Galbraith, Frank W. (TRW Systems, Redondo Beach, Calif.). Bull. Seismol. Soc. Amer., 58: 2033-41 (Dec. 1968).**

Shock spectrum measurements were made for an underground nuclear explosion at the Nevada Test Site using 29 reed gages. The objective of the measurements was to determine the effect of a fault zone on shock spectra measured at the ground surface and generated by the explosion. The reed gages were located along two gage lines; one extended to the west and crossed the fault at right angles. The other gage line extended to the north and was generally parallel to the fault. The results showed that the fault zone had an effect on vertical spectra but not on horizontal radial spectra. The vertical gage directly on the fault showed significantly lower displacements for all frequencies above 3 cps but showed no apparent effect on the 3 cps displacement. For gages beyond the fault the vertical spectra for frequencies higher than 3 cps were greater than for corresponding gages along the north gage line. It is believed that this was caused by the upthrust base rock on the side of the fault away from the explosion with a resultant decreased thickness of tuff and alluvium. This resulted in less attenuation of high frequency response than was expected. (auth)

11679 SHEAR WAVES FROM A NUCLEAR EXPLOSION IN A SALT CAVITY. **Perret, William R. (Sandia Lab., Albuquerque, N. Mex.). Bull. Seismol. Soc. Amer., 58: 2043-51 (Dec. 1968).**

Shear waves have been resolved in records of acceleration and particle velocity resulting from the Sterling event which was a nuclear explosion (380 tons) within the stable cavity left by the Salmon detonation in the Tatum salt dome. These shear waves were strongest in records of vertical motion at stations in the shot-level plane, but were detectable in records from both vertical and horizontal radial gages above and below that elevation. No appreciable shear waves could be identified in records from shot-level gages oriented horizontally. All instruments involved in this study were situated within the salt dome at ranges between 166 and 660 meters from the explosive source. Shear waves carried over 95% of the energy in vertical shot-level records, but they represented less than 11% of the energy in horizontal radial shot-level records. Cause of the vertically polarized shear waves is considered to be vertical asymmetry at the source. (auth)

11680 SEISMIC SOURCE CHARACTERISTICS FROM EXPLOSION-GENERATED P WAVES. **Trembly, Lynn D.; Berg, Joseph W. Jr. (National Academy of Sciences, Washington, D. C. Marathon Oil Co., Littleton, Colo.). Bull. Seismol. Soc. Amer., 58: 1833-48 (Dec. 1968).**

Signals from nuclear explosions were used to calibrate seismograph stations (near-regional, regional, and teleseismic ranges) by determining the transfer functions of the lumped source-propagation path-receiver systems. Recorded signals other than those used for calibration purposes were used to derive the characteristics of the sources. It was found that source functions could be derived from distant signals when the frequencies of the output signals were reliably related to the source. For the output data used in this research, the low-frequency cutoff was 0.2 cps at all stations and the high-frequency cutoffs were 4.0, 3.0, and 2.0 cps at the near-regional, regional, and teleseismic distances, respectively. The low-frequency cutoff was due mainly to the recording instruments, and the high-frequency cutoffs were due to the attenuation of the seismic energy by the Earth. The most reliable results were obtained when three half-cycles of the observed output signals (first arrivals) were used. When explosions in granite were used as calibration sources, the energies derived for explosions in tuff, alluvium, and dolomite media were 88, 65, and 12% of the respective "observed" source energies. (auth)

11681 P-WAVE TRAVEL TIMES FROM SHALLOW EARTHQUAKES RECORDED IN INDIA AND INFERRED UPPER MANTLE STRUCTURE. **Kaila, K. L.; Reddy, P. R.; Narain, Hari (National Geophysical Research Inst., Hyderabad, India). Bull. Seismol. Soc. Amer., 58: 1879-97 (Dec. 1968).**

P-wave travel times of 39 shallow earthquakes and three nuclear explosions with epicenters in the North in the Himalayas, Tibet, China, and USSR as recorded in Indian observatories have been analyzed statistically by the method of weighting observations. The travel times from $\Delta = 2$ to 50° can be represented by four straight line segments indicating abrupt velocity changes around 19, 22, and 33° respectively. The P wave velocity at the top of the mantle has been found to be 8.31 ± 0.02 km/sec. Inferred upper mantle structure reveals three velocity discontinuities in the upper mantle at depths (below the crust) of 380 ± 20, 580 ± 50, and 1000 ± 120 km with velocities below the discontinuities as 9.47 ± 0.06, 10.15 ± 0.07, and 11.40 ± 0.08 km/sec respectively. The J-B residuals up to $\Delta = 19°$ are mostly negative varying from 1 to 10 seconds with a dependence on Δ values indicating a different upper mantle velocity in the Himalayan region as compared to that used by Jeffreys-Bullen in their tables (1940). Between 19 to 33° there is a reasonably good agreement between the J-B curve and the observation points. From $\Delta = 33$ to 50° the J-B residuals are mostly positive with an average excess value of about 4 sec. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 11632, 11677–11681, 12038, and 12262.

11682 (PNE–506–F) SURFACE MOTION MEASUREMENTS. PROJECT Pre-SCHOONER. Final Report. Christopher, W. G.; Lattery, J. E. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Oct. 1968. 48p. Dep. CFSTI.

Project Pre-Schooner consisted of four 20-ton nitromethane cratering detonations conducted as part of the nuclear excavation research program. The experiment was conducted in February 1964 in the basalt of Buckboard Mesa at the Nevada Test Site. High speed photographs and target markers were used to measure ground surface motions produced by each of the four detonations. Analysis of the surface motion data indicated that spalling was the principal crater-producing mechanism. The three detonations which produced apparent craters did, however, show varying amounts of second phase surface accelerations. Surface ground zero spall velocities ranged from 100 fps for the detonation at a 66-foot burial depth (scaled depth of 236 $ft/kt^{1/3}$) to 170 fps for the detonation at a 42-foot burial depth (scaled depth of 150 $ft/kt^{1/3}$). (auth)

11683 PEACEFUL USES OF NUCLEAR EXPLOSION. Imai, Ryukichi (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 11: 20(1969). (In Japanese).

The history, outline of the basic technology, and the major contemplated uses of the Plowshare project are described. The major safety problems involved, such as the tritium level in recovered natural gas measurements and activity release from nuclear excavation are discussed. Scope and economics are outlined. (tr-auth)

11684 DETONATION THEORY AND EXPERIMENT. Davis, W. C.; Fickett, W. (Los Alamos Scientific Lab., N. Mex.). pp 2-12 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

Unsupported detonation in liquid and solid explosives restricted to high-order detonation in which the reaction zone is nearly steady (independent of time in a reference frame moving with the front), and in which the detonation front is nearly plane was investigated. Tests show that the usual hydrodynamic theory does not accurately describe the behavior of real explosives. Theoretical work which has been done since the work of Zeldovich, von Neumann, and Doering was reviewed and compared with experiments. Important conclusions from papers reviewed are given and areas where work is needed are indicated. (F.S.)

Facilities and Equipment

Refer also to abstracts 11737, 11740– 11742, 12253, 12262, 12402, 12718, 12893, 12957, 13462, and 13608.

11685 (AERE-R-5773(Vol.3), pp 779-800) EXPERIENCES IN THE PRACTICAL CALCULATION OF GAMMA SHIELDS IN THE FUEL REPROCESSING PLANT AT THE KARLSRUHE RESEARCH CENTER (WAK). Futtermenger, W. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz).

The problems and methods of calculating shields for γ-radiation in the fuel reprocessing plant at the Karlsruhe research center are reported. After a short description of the shielding problems, the basic assumptions concerning the fission rate of the fuel, the total fission number of the time of irradiation, and the time of cooling after the end of irradiation are discussed. Gamma spectra of fission products were calculated from published data and compared with each other. Numerical calculation methods and shielding codes were used in some standard geometries. A special problem was the calculation of scattered radiation in ventilation ducts in the walls. Since the differential dose albedos and energy spectra of single and double reflected radiation for exact calculation of doses are but rarely known an approximation formula was used. To prove the accuracy of the estimation Monte Carlo calculations and measurements were started. The estimated albedos in the formula were corrected by the results. In spite of the rough approximations the formula makes possible sufficiently accurate calculations. (auth)

11686 (ANL–7443) STEAM-WATER CONDENSING-INJECTOR PERFORMANCE ANALYSIS WITH SUPERSONIC INLET VAPOR AND CONVERGENT CONDENSING SECTION. Grolmes, Michael A. (Argonne National Lab., Ill.). May 1968. Contract W-31-109-Eng-38. 131p. Dep. CFSTI.

The condensing injector as a component of liquid-metal magnetohydrodynamic (LMHD) power cycles is discussed. In this application, the condensing injector would be required to generate large stagnation pressures and to convert vapor to the liquid state with minimum loss of kinetic and potential energy. A review of the literature indicated that a more realistic appraisal of the condensing injector was needed to determine the future potential of this device for large pressure augmentation in such applications. A steam-water condensing injector with inlet vapor velocities approaching Mach 1.7 and convergent condensing section was studied. Axial pressure profiles and maximum discharge pressures were obtained for various vapor and liquid inlet conditions. The observed maximum stable discharge pressures for these experiments were generally lower than predicted by the previous constant-pressure condensing model, particularly in the case of low liquid-to-vapor flowrate ratios where constant-pressure condensing was no longer achieved and the liquid jet disintegration proceeded more rapidly. Losses other than those due to vapor-liquid mixing and expansion in the minimum-area section were related to the liquid jet disintegration. Criteria for minimum liquid-vapor flowrate ratios consistent with constant-pressure condensing were verified. Details of the flow in the condensing section were obtained with gamma-ray-attenuation measurements. Complete liquid jet disintegration was observed upstream from the minimum area in this section. Initially, as the liquid and vapor jets entered the condensing section, the flow was well-defined and stratified, with the liquid jet in the central region. Near the end of the condensing section (of 4-in. length), the flow became dispersed with apparent uniform density and no evidence of a central liquid core. A relation between the inlet vapor-liquid momentum ratio and jet breakup length was determined and used to determine the transition between analytical flow models. Two analytical formulations were employed for the distinct flow patterns and joined at the point of jet breakup. A stratified condensing flow model, developed to predict the axial pressure profile up to the point of jet breakup, showed that the vapor condensing rate determined the axial pressure profile to a far greater extent than either wall or interfacial shear. At the point of jet breakup, a homogeneous flow model was employed, showing trends in the axial pressure profiles and maximum discharge pressures with various inlet conditions. In this region, the flow was found to exhibit varying degrees of similarity with single-phase compressible flow. The possible occurrence of shock phenomena was observed. The results of this investigation were related to previous condensing-injector studies and to previous liquid-metal LMHD power cycle studies. Evidence indicates that the range of liquid-to-vapor flowrate ratios and condensing-section area contraction which might actually be realized may be somewhat less optimistic than those previously considered. It may be concluded that realistic limitations in area contraction and especially in required flowrate ratios would render the condensing injector unattractive in liquid-metal LMHD power cycles operating within the conditions described by previous cycle studies. (auth)

11687 (BNWL–715(Pt.4), pp 34–42) QUALITATIVE AND QUANTITATIVE EVALUATION OF INFRARED IMAGERY COLLECTED OVER SURFACE WATER. Eliason, J. R.; Foote, H. P.; Taylor, G. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The development of recording and display techniques for interpreting infrared imagery data collected by sequentially-scanning remote-sensing systems is described. Infrared imagery collected over the Columbia River adjacent to a nuclear reactor area on the Hanford Project is used to illustrate the techniques. Initial evaluation of infrared imagery by the techniques described showed that: data collected by imaging systems can be useful for quantitative as well as qualitative studies; computer-generated displays can be produced almost as fast as the data is acquired; radiation gradients can be determined quantitatively; and three-dimensional displays facilitate an interpretation of the true intensity relationship in the imagery. Infrared imaging systems are concluded to have great potential for use in large-scale ecological research. (L.C.L.)

11688 (BNWL–SA–2198) EVALUATION OF SODIUM REMOVAL METHODS FOR FUEL ELEMENTS AND PIPING SYSTEMS. Bloom, G. R. (Battelle-Northwest, Richland, Wash.

Pacific Northwest Lab.). Nov. 4, 1968. Contract AT(45-1)-1830. 23p. (CONF-681106-9). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

Effects of three sodium removal procedures and subsequent reinsertions into high temperature sodium were determined for 304 stainless steel material samples. Sodium removal procedures used were: mercury amalgamation, Dowanol EB reaction, and argon-steam reaction. Type 304 stainless steel material samples were single specimens, crevice specimens and simulated FFTF fuel pins. Sodium exposures were in isothermal, stagnant sodium capsules at 800, 1000, 1200, and 1400°F for 500 hr. Metallographic and microscopic examinations after one and two sodium exposures followed by sodium cleaning showed no intergranular attack on the fuel pin samples exposed to 1200°F sodium. Burst tests conducted on ¼ in. dia fuel cladding samples at room temperature before sodium exposure, after one sodium exposure and one cleaning cycle, and after two sodium exposures, and two cleaning cycles showed no change in burst stress. Very thin black to light brown (and blue) colored films were formed on some of the samples exposed to 800°F and on others cleaned with the mercury process. Neither the cause of the film nor the nature of the film was determined. (auth)

11689 (K-1751) APPLICATION OF THE PERIPHERAL COMPRESSOR TO THE FLUORIDE VOLATILITY PROCESS. Stephenson, M. J.; Anderson, L. W.; Cates, P. S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 17, 1969. Contract W-7405-eng-26. 59p. Dep. CFSTI.

To lower operating costs in reprocessing plants by reducing reagent usage, gas recycle was proposed for use in the fluorination and hydrochlorination steps of the fluoride volatility process for the recovery of valuable uranium and plutonium from spent nuclear reactor fuels. A detailed description is presented of the development and testing of a prototype two-stage peripheral compressor designed for recycle service. An account is given of the maintenance requirements and operating problems encountered in over 2 years of intensive testing, including 6,200 hours of operation using mixtures of nitrogen, fluorine, and uranium hexafluoride. The overall performance and acceptability of the compressor, as it might be used in a 1-ton of uranium per day reprocessing plant, were critically evaluated and found to exceed design criteria. (auth)

11690 (LMEC-68-5(Vol.1)) MECHANICAL ELEMENTS OPERATING IN SODIUM AND OTHER ALKALI METALS. VOLUME I. LITERATURE SURVEY. Balkwill, J. K. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). [1968]. Contract AT(04-3)-700. 120p. Dep. CFSTI.

A search was made of literature reporting information published since 1950 on mechanical devices with rubbing surfaces operating in alkali metals. Sodium environments are emphasized, with data also included from potassium, NaK and lithium experiments. The characteristics of potentially useful materials that are important in liquid metal applications are discussed. Material compatibility and friction/wear testing programs conducted since 1950 are described. Experimental and operating experience with full-size components is presented. (auth)

11691 (NYO-3930-2) AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF TURBULENT FLOW IN BEARING FILMS, INCLUDING CONVECTIVE FLUID INERTIA FORCES. Period Covered: February 1968-October 1968. Smalley, A. J.; Vohr, J. H.; Castelli, V.; Wachmann, C. (Mechanical Technology Inc., Latham, N. Y.). Dec. 1968. Contract AT(30-1)-3930. 109p. (MTI-68-TR-80). Dep. CFSTI.

An analysis of hydrodynamic lubrication of bearings which takes full account of fluid film turbulence and effects of fluid convective inertial was developed. Turbulence is handled by means of the theory of thin film turbulence. Convective inertia is accounted for by convective derivatives of mean film velocities averaged over the bearing film. The analysis involves the direct numerical solution of the simultaneous equations representing conservation of momentum and fluid continuity. The analysis developed is applied to pad bearings of arbitrary geometry, and has been incorporated in a computer program to calculate the film pressures developed in such bearings. Results from this program are compared with experimental pressure profile measurements made on a 12-in. dia, four pad, shrouded step bearing with silicone fluids as test lubricants. The main conclusions reached were: the theory of full turbulent inertial conditions in pad-type bearings has been verified by experimental comparison; the effects of both fluid inertia and film turbulence tend to increase the peak pressures attained in a bearing; a major characteristic of convective inertial effects is that they tend to produce a very sharp drop in pressure at the step at the end of a pocket (these inertial pressure drops were predicted with good fidelity by the present analysis); and, a relatively small fraction of the reference dynamic head is recovered as pressure at inlet to the pad (a value of 15% for this recovery factor is recommended). (L.C.L.)

11692 (NYO-3930-3) LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE, HIGH TEMPERATURE SODIUM ROTATING MACHINERY. Progress Report, August 1-October 31, 1968. Arwas, E. B.; Hoogenboom, L.; Kissinger, C.; Orcutt, F. K.; Waldron, W. D. (Mechanical Technology Inc., Latham, N. Y.). Jan. 1969. Contract AT(30-1)-3930. 39p. (MTI-69-TR-1). Dep. CFSTI.

The analysis and computation procedures necessary to prepare the design data for large sodium lubricated bearings operating in the turbulent inertial flow regime was completed. Calculations to optimize shrouded step bearing configurations for operation with low viscosity lubricants (such as liquid sodium) and under high levels of turbulence were studied. Development of proximity (film-thickness) measuring transducers suitable for operation in high-temperature, liquid sodium ambient was started. The development of the film pressure measurement transducers for operation in high temperature sodium was completed. A sample probe is being subjected to fatigue testing to evaluate the ability of the transducer, including its diaphragm and coated surface to withstand large, cyclic pressure changes, when the probe is installed in a rotating journal, to scan the circumferential pressure profile in the bearing. The analysis and design of the test rig for conducting bearing tests with 12 inch diameter bearings in liquid sodium at up to 1200°F is proceeding. Analysis of the major components was substantially completed and preparation of detailed drawings was initiated. A design modification whereby the loader bearing was relocated to be in close proximity to the test bearing was also completed. This design modification was made in order to eliminate a shaft deflection problem and to achieve closer simulation of the loading conditions of the sodium lubricated bearings of vertical shaft sodium circulation pumps. (auth)

11693 MINIATURE CENTRIFUGAL CONTACTOR (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1810).
8 drawings.

A 16-stage, miniature centrifugal contactor developed for liquid-liquid extraction with mass transfer efficiencies of 95% at a residence time of 3 sec/stage is described. It is suitable for remote operation with highly radioactive materials. Each stage of the contactor consists of a mixing chamber and mixer and a centrifuge bowl and housing. Unmixed phases are introduced along the mixer shaft and the mixed phases are discharged radially at the periphery of the chamber. (For details see TID-4100 Suppl. 49). (F.S.)

11694 SOLVENT WASHER AGITATOR (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-1809).
5 drawings.

A solvent washer insert to provide longer residence time for vigorously washing Purex first cycle solvents is described. The insert increases the washing time from 5 to 10 min. (For details see TID-4100 Suppl. 49.) (F.S.)

11695 IMPROVEMENTS IN OR RELATING TO IRRADIATION MACHINES. McCann, John David; Fuller, Robin Walter Ellecker (to United Kingdom Atomic Energy Authority). British Patent 1,138,769. Jan. 1, 1969. Filed Aug. 8, 1966.

In electron irradiation machines using a "strip" type beam, there is difficulty, even using spring tensioning devices, to counter the effect of thermal expansion of the wire or ribbon source, especially when using wires in excess of about 12 inches in length. A method of overcoming this difficulty is described whereby a magnetic field transverse to the axis of the elongated electron emitter (or source) is provided, so that the interaction between the field and the emitter when carrying its operating current supports the weight of the emitter along its length. (UK)

11696 GAS-TIGHT CLOSURE FOR PRESSURE CONTAINERS. (to Rheinstahl Huttenwerke AG). British Patent 1,140,609. Jan. 22, 1969. Priority date Aug. 2, 1965, Germany.

A gas-tight closure between a pressurized container and its cover is described. A flange of the container and a flange of the cover form a sealing seating. A cylindrical collar is provided with a heating system to heat and expand the collar which peripherally surrounds the cover flange. Strut members are inserted between a flange ring secured to the collar and the cover flange. The strut members which are inclined in relation to the vertical axis of the container, transmit the pressure between the flanges when the collar cools after the heating operation. (F.S.)

11697 IMPROVEMENTS IN OR RELATING TO INJECTION APPARATUS. Clayton, Colin Geoffrey; Spackman, Ramon (to United Kingdom Atomic Energy Authority). British Patent 1,140,032. Jan. 15, 1969. Filed Jan. 20, 1965.

A method of injection is described comprising withdrawing a subsidiary flow of liquid from a main stream, injecting a radioisotope into this subsidiary flow of liquid, passing the subsidiary flow of liquid after addition of the isotope through a pump, whereby thorough mixing is achieved, and injecting the subsidiary liquid into the main stream in such manner that the quantity of subsidiary liquid reaching any point downstream of the position of injection is substantially proportional to the velocity of the main stream at a corresponding point immediately upstream of the position of injection. The method has particular application in flow measurements in the concrete conduits for cooling water in power stations. (UK)

11698 IMPROVEMENTS IN OR RELATING TO REMOTE CONTROLLED MECHANICAL HANDLING APPARATUS. Orloff, George (to Molins Machine Co., Ltd.). British Patent 1,138,983. Jan. 1, 1969. Filed Mar. 10, 1965.

An arrangement is described in which two mechanical handling apparatuses, are mounted on a vehicle without the limitation in that specification of a one-to-one relationship between the secondary and main members, but with each handling apparatus adopted for independent swivelling about an axis. For operation on land, a vehicle such as an armored car, with the armament removed, can be used with the handling apparatuses mounted on each side of a slewing turret, each apparatus being arranged for independent slewing about its own vertical axis, and remote controls being provided in the turret to permit simultaneous operation by a single operator. (UK)

11699 IMPROVEMENTS IN SPACER GRIDS FOR HEAT EXCHANGE UNITS. Hartwell, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,140,243. Jan. 15, 1969. Filed Oct. 6, 1965.

A spacer grid of the kind formed from a solid plate is described for locating a plurality of elongate heat exchanger elements (either in the form of tubes containing heat carrying fluid, or as fuel elements in a nuclear reactor). The bored plate spacer grid comprises an outer layer having bores for receiving the elements with a touch fit, and other bores interfering with the touch fit bores, an opposite outer layer having counterbores for the touch fit bores, and an intermediate layer in which the interfering bores and the counterbores interpenetrate to leave pillars by which are carried star-shaped pieces remaining in the outer layer. The method of boring out the plate is outlined. (UK)

11700 AN ENERGY METHOD OF NATURAL-MODE FREQUENCY ANALYSIS OF A TURBINE DISK SUBJECTED TO UNIFORM ROTATION AND TEMPERATURE GRADIENT. Soo, Paul P. (Aerojet-General Corp., Sacramento, Calif.). pp 977-94 of Developments in Mechanics. Vol. 4. Cermak, J. E.; Goodman, J. R. (eds.). Fort Collins, Colo., Midwestern Mechanics Conference, 1968.

From 10th Midwestern Mechanics Conference, Fort Collins, Colo. See CONF-670845.

An energy method for determining the natural frequencies of a turbine disk of variable thickness subjected to uniform rotation and to radial temperature gradients is presented. The basic approach used in this method assumes a normal deflection function expressed in a finite power series, matching the particular boundary conditions of the turbine disk. The coefficients of the deflection function in the potential and kinetic energy expressions for the entire disk are then minimized by Ritz's procedure, yielding a set of integrated algebraic equations. Equating to zero the determinant of this set of equations will yield the natural frequencies of the turbine disk. The analytical result obtained may be considered as an adequate approximation of the free vibration solution of a rotating disk of distributed mass. Certain portions of the analysis are mathematically intractable, and a computer program has been developed to complete the solution of this problem. A series of vibration shake tests of the NERVA turbine disk have been conducted, and the results obtained agree well with the disk frequencies predicted by the energy method. (auth)

11701 DEVELOPMENTS IN MECHANICS. VOLUME 4. Proceedings of the Tenth Midwestern Mechanics Conference held at Colorado State University, Fort Collins, Colorado August 21-23, 1967. Cermak, J. E.; Goodman, J. R. (eds.). A Midwestern Mechanics Conference Publication. Fort Collins, Colo., Midwestern Mechanics Conference, 1968. 1641p. (CONF-670845).

Ninety-two papers were presented at the conference. A separate abstract was prepared for four papers. The remaining 88 papers were not within scope of NSA. (R.C.K.)

For abstracts of individual papers see: 11700, 12620, 12621, and 12629.

11702 SPINCTER SEAL (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1818).

7 drawings.

A spincter seal is described that is installed in the wall of a controlled atmosphere enclosure such as a glove box to provide a sealed transfer port to permit the introduction of small articles into the enclosure without breaching the enclosure barrier. (For details see TID-4100 Suppl. 50.) (F.S.)

11703 MEGAGAUSS FIELDS AS A TRANSMITTING MEDIUM FOR VERY HIGH PRESSURES. Knoepfel, H. pp 521-8 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

Transient magnetic fields at the megagauss level transmit to electrical conductors pressures of the order of megabar. The advantage of such a compression device lies mainly in the accessibility of the compressed specimen and in the possibility to sustain the high pressures during many μsec. The advantages and potential limitations of this method are analyzed and discussed on the basis of extensive experimental experience in the domain of explosively generated megagauss fields. (auth)

11704 BRACING GRIDS FOR NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Ridgway, James; Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,138,967. Jan. 1, 1969. Filed Dec. 20, 1965.

In nuclear fuel element assemblies consisting of a cluster of parallel, sheathed fuel rods, transverse bracing grids are generally used at intervals along the lengths of the fuel rods, e.g., as in the steam-generating heavy-water-moderated power reactor. The grid described is machine cut from solid material and can be made economically in large quantities. It comprises a cellular plate having a central cell penetrated by a tubular member to form a hub, the plate and hub being secured together by mechanical means. The fuel rods are disposed at spaced intervals about the central tie member. The cells for penetration by the fuel rods have irregular contours which define concyclic bearing surfaces for the fuel rods and flow paths for the coolant through the grid. (UK)

11705 NINETEEN-ROD CLUSTER FUEL ELEMENT MARK I (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE-1813).

4 drawings.

Nineteen-rod PRTR fuel elements are described. These consist of clusters of 0.565 in. OD Zircaloy-clad rods with active lengths of 58.5 and 88.5 in. The rods are used in pressure and temperature tests in large-scale burnup experiments to provide information on operating characteristics of a Pu fueled power reactor. The reactor fuel is vibrationally compacted PuO_2-UO_2. (For details see TID-4100 Suppl. 50)(see also 22: 2707.) (F.S.)

11706 USE OF RADIOISOTOPES FOR LABELING OF REFRACTORY MATERIALS USED IN FOUNDRIES. Descamps, Cl. (Belgonucleaire, Brussels). Bull. Soc. Fr. Ceram., No. 78, 61-74(1968). (In French).

General aspects of the problems encountered in labeling production units in foundries are noted, and isotopes amenable to such studies for refractories would include ^{24}Na, ^{27}Mg, ^{28}Mg, ^{28}Al, ^{31}Si, and ^{42}K. More appropriate to the present study is ^{95}Zr, which can be incorporated in a typical foundry sand with silica. Simple mixing with silica to produce an inhomogeneous zircon-silica mixture was used to study labeling of casting units of several items. Labeling by other means include immersion of the refractory piece and aspersion on the faces with solutions of $^{95}Zr(NO_3)_4$; distribution of ^{95}Zr into the interior of the unit was studied for each of these methods. The aspersion method was adopted, and a labeling device was constructed based on this technique. This is described in detail and illustrated. Applications and results of routine analyses are quoted. (BBB)

11707 A LABORATORY FOR THE STUDY OF PLUTONIUM RECOVERY IN A PROCESS FOR NUCLEAR FUEL RETREATMENT BY A DRY ROUTE. Vandersteene, J.; Camozzo, G.; Heremans, R. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Ind. Chim. Belge., 33: 641-8(July-Aug. 1968). (In French).

The equipment of a laboratory for studying Pu reprocessing by a dry fluoride volatility method is described. Construction of the infrastructure is described, including the location, equipping of the α chambers, and problems of ventilation. Internal installations for the units include chemical apparatus for studies of O_2 oxidation, HF treatment, and treatment with ClF, ClF_3, and F_2, and also an arrangement for sampling. Safety problems are discussed, both with respect to nuclear hazards and hazards resulting from the fluorinating agents. The laboratory is equipped with a double detection system, an indirect control, and continuous monitoring; personnel wear neutron badges, and a continuous neutron detector is in operation in the laboratory. Schematics for the volatilization and recovery of PuF_6, and for its reduction to PuF_4 by SF_4, are illustrated. (BBB)

11708 COUNTING SHIELD (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). CAPE-1817).

11 drawings.

A large lead-filled steel shell counting shield with a graded liner is described. The main shell uses lengths of Standard Schedule 10 steel pipes. The shield is designed for service in a field trailer where it is subjected to road vibrations and broad temperature fluctuations. The cover is easy to open or close without power assistance. The latch requires 2 hands for opening and closing which minimizes possible injury to hands and fingers. Locking lugs are provided for use during transport. (For details see TID-4100 Suppl. 50.) (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 11691, 11697, 11699, 11721, 13485, 13491, 13492, 13587, and 13588.

11709 (AE-343) FRICTION FACTORS IN ROUGH ROD BUNDLES ESTIMATED FROM MEASUREMENTS IN PARTIALLY ROUGH ANNULI: EFFECTS OF DISSIMILARITIES IN THE SHEAR STRESS AND TURBULENCE DISTRIBUTIONS. Kjellstroem, Bjoern (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1968. 26p. Dep.

Experiments with rough surface friction and heat transfer are often made in an annulus with rough inner surface and smooth outer surface. Utilization of data from such experiments for calculation of rough rod bundle fuel elements requires a transformation of the data. For this purpose the method by W. B. Hall is frequently used. The errors introduced by two of the assumptions on which this method is based, namely the assumptions of zero shear at the radius of maximum velocity and the assumption of no turbulence exchange between the subchannels, are discussed. The magnitude of the errors was estimated on the basis of experiments in a partially rough annulus. It was found that the necessary corrections do not amount to more than about +10 percent for the friction factor and +15 percent for the Reynolds number and the equivalent diameter. The correction for the turbulence exchange alone is of the order of 2-3 percent. A comparison of friction factors measured in rough 48-rod bundle and predicted from measurements in a partially rough annulus was also made. The prediction was 5 percent high instead of about 10 percent low which could have been expected from the considerations earlier in the report. Explanations for this can be found in the effect of the channel shape or inaccuracies in the rod bundle experiment. (auth)

11710 (ALO-3634-11) RESEARCH AND DEVELOPMENT OF VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Quarterly Progress Report, September 1968-November 1968. Carvalho, J.; Dunlay, J. B.; Fronduto, J.; Paquin, M. L.; Poirier, V. L. (Thermo Electron Corp., Waltham, Mass.). Jan. 20, 1969. Contract AT(30-1)-3634. 91p. (TE-4059-109-69). Dep. CFSTI.

Progress is reported on the development of high-temperature thermal insulation for radioisotope power systems. Additional data relating to the oxide coating density optimization studies have been obtained. The insulation samples for the reproducibility tests have been fabricated and the standard deviation of the oxide coating densities was only 5.6%. The initial series of uniform loading heat transfer tests has been completed and a sizeable heat flux increase was noted. Comparisons with planar data indicated that compressive stresses of 2 to 3 psi acted on the insulation. The concentric cup corner assembly was fabricated and evaluated in the edge heat loss test apparatus. The thermal losses varied between 0.1 watt/cm of edge at 900°C to approximately 1.0 watt/cm of edge at 1700°C. Additional Pt$-ZrO_2$, Al$-ZrO_2$, Cu$-ZrO_2$, and SS$-ZrO_2$ data are presented in the 200 to 700°C temperature range. (auth)

11711 (CEA-Bib-128) NATURAL CONVECTION: THE PARTICULAR CASE OF LIQUID METALS. Martin, Robert (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sept. 1968. 47p. (In French). Dep.

A review of the main theoretical and experimental results concerning natural convection in fluids having Prandtl numbers equal to, or greater than one is presented. The difficulty of the application of this mode of heat transfer to molten metals is shown. A listing of 125 references is given. (tr-auth)

11712 (EUR-4188) PART OF THERMAL NON-EQUILIBRIUM IN BOILING CO-CURRENT FLOW. Wundt, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 8, 1968. 26p. Dep.

Elementary mechanisms of thermal non-equilibrium in boiling processes were considered with emphasis on the radial temperature and vapor distributions in co-current gas-liquid flow through a heated vertical tube. Vapor may be considered to be at saturation temperature in a boiling co-current flow. However, when the liquid is superheated near the wall; its temperature falls toward the tube axis. The amount of liquid superheat as well as nucleation frequency depend on the surface roughness. For rough surfaces the liquid temperature is sufficiently flat so that no major problems occur in defining a liquid temperature. With smooth surfaces troubles may occur because of pronounced non-equilibrium states with latent vapor retention. (F.S.)

11713 (ORNL-4345) TEMPERATURE PROFILES WITHIN CYLINDERS CONTAINING INTERNAL HEAT SOURCES AND MATERIALS OF TEMPERATURE-DEPENDENT THERMAL CONDUCTIVITIES. DESCRIPTION OF FAST COMPUTER PROGRAMS AS APPLIED TO SOLIDIFIED RADIOACTIVE WASTES. Davis, W. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 32p. Dep. CFSTI.

The safety and economic aspects of producing and storing radioactive wastes as solids, usually in vessels having a cylindrical geometry, require that we know the maximum internal temperatures to be expected as a result of decay heat. Such information is mandatory for materials that have variable thermal conductivities under different storage conditions. A computer program (STORE) is presented, which was written to permit more rapid calculation of temperature profiles within cylinders containing homogeneously distributed heat sources and materials whose thermal conductivities can be expressed as a tabular function of temperature. A simplified version of this program was prepared for the cases in which the thermal conductivity is constant or is a linear function of temperature. Both of these programs have short execution times, typically from a few to 20 seconds on the IBM/360-75 as compared with the five or more minutes required for the more accurate finite-difference method. They are based on the assumption that the material density and, therefore, the power density of the heat source are independent of temperature; this assumption is, of course, contrary to physical reality. However, in a test example involving a hypothetical vessel of glass containing a large internal (fission product) heat source with a specific power density of 0.2 cal sec^{-1} cm^{-3} (i.e., 80,910 Btu hr^{-1} ft^{-3}), the temperature difference between the wall and the center of a 6-in.-diam by 6.25-ft-long cylinder was overestimated by 36°C (an error of only about 10%, as compared with the "exact" value that is obtained by solving finite-difference equations and compensating for the reduction in the heat-source strength as the density decreases with increasing temperature). Within the uncertainties inherent in thermal conductivity, density, and heat capacity measurements of systems of interest in the storage of solidified radioactive process wastes, the method and the program presented offer adequate accuracy and a large time savings as compared with the more exact calculations. Also, they are applicable to cylinders with any specified length/diameter ratio. (auth)

11714 (SU-326-P-13-3) A STUDY OF RADIATION-INDUCED NUCLEATION OF BUBBLES IN SUPERHEATED WATER. Annual Progress Report. Deitrich, L. W.; Connolly, T. J. (Stanford Univ., Calif. Dept. of Mechanical Engineering). Dec. 23, 1968. Contract AT(04-3)-326. 16p. Dep. CFSTI.

Work was carried out to make the bubble chamber radiation sensitive. This resulted in the achievement of bubble nucleation by fission fragments emitted from a $^{235}UO_2$ plate. A measurement of the superheat threshold for nucleation by fission fragments was obtained over the range from 380 to 440°F. (M.C.G.)

11715 HEAT TRANSFER IN FILM AND DROPWISE CONDENSATION OF LIQUID METAL VAPORS. Ivanovskii, M. N.; Milovanov, Yu. V.; Sorokin, V. P.; Subbotin, V. I.; Chulkov, B. A. (Atomic Energy Inst., Obninsk, USSR). Heat Transfer - Sov. Res., 1: 96-102(Jan. 1969).

Heat transfer in dropwise and film condensation of liquid metal vapors is characterized. The effects of wall wetting, surface condition, purity of the metal, presence of incondensibles, etc., on heat transfer are discussed. Comparison of experimental data with theoretically derived equations is made. Results of analog computer calculations are correlated and analyzed. (auth)

11716 SIMILARITIES AND DIFFERENCES IN POOL BOILING HEAT TRANSFER OF LIQUID METALS AND NONMETALLIC LIQUIDS IN CONDITIONS OF FREE CONVECTION. Subbotin, V. I.; Ovechkin, D. M.; Sorokin, D. N.; Kudryatsev, A. P. (Atomic Energy Inst., Obninsk, USSR). Heat Transfer - Sov. Res., 1: 93-5(Jan. 1969).

An analysis of similarities and differences between pool boiling of liquid metals and nonmetallic liquids is made on the basis of both theoretical and experimental considerations. Some conclusions regarding factors affecting such differences and similarities are presented. (auth)

11717 HEAT TRANSFER TO LIQUID METALS FLOWING THROUGH AN ANNULAR DUCT. Borishanskii, V. M.; Zablotskaya, T. V.; Nemirovskii, V. L.; Firsova, E. V. (Central Boiler Turbine Inst., Leningrad). Heat Transfer - Sov. Res., 1: 1-5(Jan. 1969).

An experimental study of heat transfer to a liquid metal with a high degree of purity is described. The data obtained represent the maximum values of heat transfer coefficients for a given d_1/d_2 ratio. These results compare favorably with available semiempirical computations which do not take into account the physical and chemical conditions at the wall-liquid metal interface. (auth)

11718 APPROXIMATE ANALYTICAL FORMULATION OF THE THERMODYNAMIC PROPERTIES OF SATURATED STEAM AND WATER AS FUNCTION OF PRESSURE. Marini, P. F.; Muscettola, M. (Centro Informazioni Studi Esperienze, Milan). Energ. Nucl. (Milan), 16: 48-52(Jan. 1969).

The thermodynamic properties of saturated steam and water are often required as a function of pressure. Therefore, using values given in water-steam tables, simple polynomial expressions have been developed for interpolating the thermodynamic properties of saturated water and steam versus pressure for the pressure range of 0.01 to 130 kbar. The analytical expression derived for interpolating each property is given, and the calculated results are tabulated. An interpolation error of 0.01% has been assumed. (L.C.L.)

11719 FULLY DEVELOPED TURBULENT HEAT TRANSFER IN CONCENTRIC ANNULI WITH UNIFORM WALL HEAT FLUXES. Quarmby, Alan; Anand, R. K. (Univ. of Manchester, Eng.). Chem. Eng. Sci., 24: 171-87(Jan. 1969).

An analysis is presented of turbulent heat transfer in concentric annuli for the case in which there is a uniform wall heat flux at either annular surface. The case in which uniform, but arbitrarily different, uniform heat fluxes are present at each surface follows by the principle of superposition. The formulation of the analysis takes into account the radius ratio and Reynolds Number dependence of the turbulent velocity profile and of the radius of maximum velocity. Calculations are made for radius ratios from unity to 50 with Reynolds Numbers from 8,000 to 500,000 for the Prandtl Numbers 0.01, 0.7, 10, 100, 1000. There is good agreement with experimental results for Pr = 0.7 over most of this range of variables, and satisfactory agreement is obtained with some experiments for other Prandtl Numbers. (auth)

Isotope Technology

Refer also to abstracts 11541, 11550, 11555, 11639, 11710, 11728, 11739, 11756, 12149, 12323, and 13606.

11720 (AI-AEC-12753) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE (LRHSC). Fifth Quarterly Progress Report, July-September 1968. (Atomics International, Canoga Park, Calif.). Nov. 15, 1968. Contract AT(29-2)-2338. 51p. Dep. CFSTI.

Progress is reported on the development of a large radioisotope heat source capsule capable of operating in a space environment at a surface temperature of about 2000°F for five years or more. The objectives of the program are to design, fabricate, test, and evaluate a test capsule whose design takes into account the operating requirements of a typical heat source. Progress is reviewed in the following tasks: program management; capsule design; process development; fabrication and assembly; creep testing; and impact testing. (L.C.L.)

11721 (ALO-2661-11) DEVELOPMENT OF 400 TO 2200F FIBROUS-TYPE INSULATIONS FOR RADIOISOTOPE POWER SYSTEMS. Quarterly Progress Report No. 8, October 1-December 31, 1968. Collins, J. O.; Jaunarajs, K. L.; Reid, D. R. (Johns-Manville Research and Engineering Center, Manville, N. J.). Jan. 2, 1969. Contract AT(29-2)-2661. 31p. Dep. CFSTI.

The thermal conductivity study of the MIN-K Formulations developed under Phase I uncovered what may have been the cause of the earlier erratic data. If further testing confirms these findings, the Guarded Hot Plate test procedure for evaluating MIN-K at temperatures above 800°F mean may require significant alteration. Attempts to manufacture an opacified Glasrock product were concluded unsuccessfully. Additional load-bearing data were subsequently obtained for the unopacified product. (auth)

11722 (DP-1158) RADIATION SHIELDING FOR SMALL POWER SOURCES OF ^{170} ^{171}Tm. Sanders, S. Marshall Jr.; Kerrigan, William J.; Albenesius, Edward L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1969. Contract AT(07-2)-1. 18p. Dep. CFSTI.

Dose equivalent rates measured with a 6.8 W ^{170,171}Tm source shielded with tantalum agreed closely with rates calculated from the number and energy distribution of bremsstrahlung photons from the beta decay of ^{170}Tm. This excellent agreement validated the calculational method. Shielding requirements were estimated for a hypothetical 62 W power source of ^{171}Tm for the projected artificial heart application; the calculations suggest a required purity range of 10^{-4} to 10^{-5} Ci ^{170}Tm Ci ^{171}Tm for ^{171}Tm implanted in the human body. (auth)

11723 (ORNL-tr-2048) INVESTIGATIONS ON THE DENSITY DETERMINATION OF WATER-SAND MIXTURES BY ISOTOPE TECHNIQUES. Pahlke, H.; Schob, W. Translated for Oak Ridge National Lab., Tenn., from report BMwF-FBK-68-23(1968). 150p. Dep. CFSTI.

The applicability of isotope techniques for density determinations on water-sand mixtures was studied by theoretically and experimentally investigating the absorption and scattering of nuclear and x radiation and the moderation of neutrons by liquids, solids, and their mixtures. Suitable sources, detectors, and electronic equipment for continuous and automatic measurements in laboratories and on board dredgers and the evaluation of their results are described. By measuring the concentration of a water-sand mixture by its interaction with radiation and by measuring the mean velocities of water and sand by isotope tracer techniques the hydraulic transport of solids can be determined. The accuracy was shown to be sufficient in all practical cases. (auth)

11724 PRODUCTION OF A ^{147}Pm LIGHT SOURCE. Wolf, P.; Rottmann, W. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Radiochim. Acta, 10: 168-70(Dec. 1968). (In German).

The preparation of a $^{147}Pm_2O_3 - ZnS(Cu)$ light source is described. An assembly of 5 quartz cells with 100 Ci in each and 10 photocells operates as a battery. (auth)

11725 COMBINATION OF DIFFUSION AND CONVECTION FOR ISOTOPE SEPARATION. Miller, L. (National Chemical Research Lab., Pretoria). J. S. Afr. Chem. Inst., 21: 84-6(Apr. 1968).

The basis of the method is to induce diffusion by a slight separation effect based on the differences of isotopic masses. The slightly enriched gas fraction is then removed by conviction, preventing re-mixing and conveying it to the next step of separating diffusion in a cascade. The use of diffusion-induced convections is not required, but unstable systems can be used in which a heavy gas is placed above a lighter isotopic gas with barriers in the upper cell of the heavy gas. The light gas then diffuses upwards through the first barrier so that a Benard cell is formed which rises to the second barrier and is stopped. When convective circulation begins in the first interspace, diffusion begins through the second barrier and makes the second interspace unstable, and so on. The convections result in an acceleration of the diffusion of the lighter isotopes of the light component. Twelve minutes after the start of diffusion of Ar upwards through SO_2, a sample was drawn at the top of the upper cell. The ^{36}Ar content in this sample was found to be 2.1% higher than in the blank. In a longer cell with more membranes, the top cell was filled with Freon 22 (m.w. = 86.5) and the bottom cell was filled again with argon. A sample drawn after 62 min had the ^{36}Ar enriched by 8.5%. Studies of the cascade mechanism showed that diffusion is the rate-determining factor of the process. The principles outlined above are also applicable for liquids. (BBB)

11726 DETERMINAREA UZURII CU RADIOIZOTOPI. (Wear Determination by Radioisotope). Chisu, Al.; Szabo, A. Bucuresti, Editura Tehnica, 1967. 319p.

Aspects and problems in industrial uses of radioactive isotopes used as tracers for determining the wear in machine construction are discussed. General data are given on physico-chemical methods for production of radioisotopes and their application in radiochemistry, radiobiology, heavy and light industry and in agriculture. Descriptions are given of various electron and nuclear counters and uses and performance. Permissible doses and personnel radioprotection are also discussed. 105 references. (R.V.J.)

11727 USE OF SEALED RADIOACTIVE SOURCES IN THE INSPECTION OF MATERIALS AND STRUCTURE. Robba, M. (ISML, Novara, Italy). Met. Ital., 60: 240-6(Oct. 1968). (In Italian).

The characteristics of sealed radioactive sources are described with respect to the type and energy of the radiation, the radioactive element used, the radioactivity level, and the physiochemical state and toxicity. Typical uses of both fixed and mobile units are given and the problems of organization and protection are considered. The principal advantages of sealed sources are the absence of contamination dangers, modest activity levels, and present widespread knowledge of the radiographic technique by the metallurgy industry. (J.S.R.)

Materials Testing

Refer also to abstracts 11727, 11921, and 12262.

11728 (BNWL-918) NONDESTRUCTIVE TESTING OF ISOTOPE CONTAINMENT CAPSULES: REMOTE ULTRASONIC TEST STATION UT-40. Steffens, R. W.; Coffman, F. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

An ultrasonic test station, UT-40 was designed for the remote evaluation of the container integrity of fueled isotope capsules. The tester consists of two parts: an ultrasonic test tank which is placed in the hot cell, and an electronic console which is placed outside the cell. The test tank provides for rotation of the capsule; axial translation of the ultrasonic transducer; linear and angular positioning of the ultrasonic transducer; devices to monitor the location of the incident ultrasonic beam on the capsule; and provisions for circulating cooling water. The electronic console provides motor controls for the test tank; electrical power for ultrasonic-beam position monitoring devices; broadband excitation for the ultrasonic transducer and amplification of the resulting signals; analog synthesis of the ultrasonic signals; and recording of defect signals as a function of circumferential and axial defect position on the capsule. An oscilloscope is used with the test station for equipment calibration and monitoring test waveforms. The ultrasonic test tank will readily facilitate right cylinder capsules other than the SNAP-21 capsules, by replacing the SNAP-21 collar with a collar of the proper diameter. Cylinders with diameters up to 8 in. and lengths up to 12 in. can be tested. The electronic console portion of this ultrasonic test station was designed as a general-application broadband ultrasonic instrument with special facilities for integration with the SNAP-21 test tank. Thus the electronic console can be used for a variety of ultrasonic test applications in addition to providing instrumentation for the isotope capsule testing. The operating instructions for the test tank and electronic console are given and the digital logic and special circuits in the electronic console described. (auth)

11729 (CEA-CONF-1071) THEORETICAL AND EXPERIMENTAL STUDY OF SOME ULTRASONIC EMITTERS. Broudin, Y.; Ferenczy, G.; Marini, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 29p. (In French). (CONF-680606-12). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

In certain problems related to nondestructive testing, the detection of small defects requires a knowledge of the energy distribution inside the scanning beam. If the beam used for probing has a much larger width than the size of the reflecting surface of the defect, the defect could produce different signals depending on whether it is in a zone of low acoustic energy or in one of higher acoustic energy. Therefore, a theoretical study of the acoustic field of some circular, rectangular, and line focussed emitters was undertaken, and experimental work to verify the theory was performed. The experimental work showed that diffraction effects are very important, even when the transducer is excited by pulses, and that the energy distribution inside the ultrasonic beam is extremely complex and can vary considerably from one point to another. (auth)

11730 (CEA-CONF-1073) DESCRIPTION OF CSF-67 EDDY-CURRENT TESTING APPARATUS AND FIRST RESULTS. Pigeon, M.; Destribats, M. T. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Desclee, B. (Societe Leanord, Lille (France)). [1968]. 22p. (In French). (CONF-680606-10). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

An eddy current testing apparatus, developed for examining reactor fuel cladding, is described, and the results obtained on several types of stainless steel, magnesium, and beryllium cladding are given. (L.C.L.)

11731 (CEA-CONF-1075) DEVELOPMENT OF NEUTRON RADIOGRAPHY WITHIN THE CEA. Boutaine, J. L. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1968]. 23p. (In French). (CONF-680606-4). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

In 1966 the first neutron radiography tests were carried out by the CEA in the swimming pool reactors PEGGY at Cadarache and MELUSINE at Grenoble on experimental rigs. Since then, it has been possible to refine the process and to develop certain particular uses of this nondestructive inspection method. The advantages and disadvantages of the neutron radiography method are summarized. The devices in service in the CEA are described and some examples of their present-day practical use in nuclear technology are given as well as some suggestions for their use outside nuclear energy. The first results of research on the possibilities of using neutron generators and radioisotopic sources are described. (auth)

11732 (CEA-CONF-1080) ULTRASONIC INSPECTION OF THE INTERNAL QUALITY OF CAST URANIUM ALLOY TUBES. Astier, P.; Oquidam, B. (Compagnie pour l'Etude et la Realisation de Combustibles Atomiques, Romans-sur-Isere (France); Papezyk, F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 24p. (In French). (CONF-680606-3). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

Metal fuel elements produced in the form of tubes by casting can have internal casting defects which are at present inspected by gammagraphy. In view of the disadvantages or limitations of this process, a method for ultrasonic inspection was devised. The use of a focussing transducer leads to a high-definition technique. However, it was found that with a single transducer the amplitude of the echo recorded is not characteristic of the size of the defect concerned. It was therefore necessary to define a two-dimensional record independent of the amplitude of these echoes. The apparent area of the defects is then recorded in the form of a chart of the developed surface of the tubes. A special electronic device also makes it possible to distinguish the various defects on the diagram itself according to their position within the tube material. The apparatus is described, and tube inspection results are compared with gammagraphic results. The method is concluded to be particularly advantageous for examining uranium tubes. (auth)

11733 (CEA-CONF-1081) ULTRASONIC MEASUREMENT OF THE GRAIN SIZE OF HEMISPHERICAL PARTS MADE OF URANIUM ALLOY CONTAINING 0.2 PERCENT VANADIUM BY WEIGHT. Deleuze, M. P. (Commissariat a l'Energie Atomique, [Paris] (France)). [nd]. 27p. (In French). (CONF-680606-9). Dep.

From Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France.

An ultrasonic method for measuring the grain size of hemispherical parts made of uranium alloy containing 0.2% vanadium by weight is described. This nondestructive test is performed on the whole volume of the machined parts, by immersion and by echo. The amplitude of the first bottom echo of the part examined is compared with that of the same echo on a standard of known grain size. (auth)

11734 (RD/B/N-1152) STRESS CONCENTRATION FACTORS AROUND A PENETRATION IN A STRIP OR SLAB OF FINITE DIMENSIONS. O'Connell, J. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 12p. Dep.

Experimental and theoretical examinations of the stress concentration effect of openings in pressure vessels are often carried out on rectangular slabs of finite width. The errors involved in using a penetration in a finite width slab to simulate a penetration in a much larger area are examined. Such errors are particularly critical in the examination of openings in concrete vessels, due to the susceptibility of the material to cracking at relatively low values of tensile stress. (auth)(UK)

11735 IMPROVEMENTS IN OR RELATING TO RADIOGRAPHIC EXAMINATION USING NEUTRONS. Barton, John

Penrose (to United Kingdom Atomic Energy Authority). British Patent 1,138,537. Jan. 1, 1969. Filed May 13, 1965.

A method of radiographic examination using neutrons is described in which the neutrons which pass through the object under examination fall on a first layer comprising a material which emits charged particles under neutron irradiation (e.g., lithium-6), a second layer of material (e.g., selenium) being positioned in the path of the charged particles, the arrangement being that the impingement of the charged particles on the second layer produces an electrostatic charge on the second layer the intensity pattern of which charge corresponds to the intensity distribution of the neutrons passing through the object. A powder is deposited on the charged areas of the second layer, and the pattern of powder from the second layer is transferred to a base material such as paper to form a visible image. The method is thus similar to xerography or xeroradiography, with the difference that the pattern of electrostatic charge is formed by the charged particles resulting from neutron irradiation, instead of light or x-irradiation. (UK)

11736 PHOTOSENSITIVITY OF SELENIUM ROENTGENOGRAPHIC PLATES DURING γ IRRADIATION. Rakauskas, Yu. K. (Inst. of Electrography, Vilnus, USSR). Defektoskopiya, No. 6, 66-9(1968). (In Russian).

The photosensitivity of selenium roentgenographic plates was studied as a function of the thickness of the layer during irradiation by ^{137}Cs, ^{192}Ir, and ^{170}Tm. Comparisons were made of the screen thickness and amplification factors for the selenium plates and x-ray films. The energy and trajectory of Compton electrons in selenium and lead were calculated. Data obtained showed that selenium plates 200 μm with the 20 l/r photosensitivity to 80 kV x radiation can be used effectively for radiography with ^{170}Tm γ rays. Selenium layers (500 to 600 μm) or 200 μm layers with amplifying lead screen of 50 μm should be used for harder γ radiation of ^{137}Cs and ^{192}Ir. (R.V.J.)

Radioactive Material Handling

Refer also to abstracts 11396, 11713, and 12270.

11737 (BNWL-832) WASTE SOLIDIFICATION PROGRAM. VOLUME III. DESIGN FEATURES OF THE FACILITIES AND EQUIPMENT FOR THE WSEP PRODUCT EVALUATION PROGRAM. Kelly, V. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 94p. Dep. CFSTI.

A program, termed the WSEP (Waste Solidification Engineering Prototype) Product Evaluation Program, was established to evaluate properties such as waste pot integrity and solidified waste stability relating particularly to the nuclear safety aspects of waste management. Three separate activities are involved: nondestructive and destructive testing such as waste pot leak testing, wall thickness measuring, fission product heat generation rate measuring, pot weight and dimension measuring, and pot sampling by rotary core drilling; controlled environment storage of waste pots in the Solids Storage Engineering Test Facility under conditions permitting continuous surveillance of pot pressures and temperatures, and maintaining the pot under various gas, liquid, or solids storage environments during the test storage period; and laboratory scale studies of properties of actual solidified high level waste in the Hot Laboratory Facility using samples obtained by coring pots or by taking dip samples of waste melts during filling. The Product Evaluation Program, expected to extend up to 5 years, will be followed by removal of pots to "final" facilities. Facilities and equipment provided for the Product Evaluation Program are described. The safety analysis reviews and equipment design verification test results are also summarized. (auth)

11738 (BNWL-945) MATHEMATICAL MODELS FOR UNDERGROUND INJECTION OF GASEOUS WASTES INTO THE VADOSE ZONE. King, L. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 149p. Dep. CFSTI.

Mathematical models which describe the flow of compressible gas through porous media were developed as part of a research program investigating the feasibility of underground disposal of gaseous wastes following a nuclear reactor incident. The models describe gas movement through ground during injection via a single well above the regional water table. With respect to permeability, the porous media can be treated as homogeneous and isotropic, heterogeneous and isotropic, or homogeneous and anisotropic. Solutions for the two homogeneous cases are presented in dimensionless graphical form for a wide range of conditions. The models were applied to two different types of tracer studies conducted in the field at the National Reactor Testing Station. For helium tracer tests conducted in shallow alluvium, the homogeneous, isotropic model resulted in satisfactory comparison of calculated and measured conditions. For xenon tracer tests in the fractured basalt, the homogeneous, anisotropic model was needed for satisfactory agreement. (auth)

11739 (MLM-1523) SUBCRITICAL NEUTRON MULTIPLICATION EXPERIMENT WITH FOUR SNAP-19B (IRHS) HEAT SOURCES CONTAINING ^{238}Pu. Wolfe, R. A.; Stubbins, W. F. (Mound Lab., Miamisburg, Ohio). Jan. 24, 1969. Contract AT-33-1-GEN-53. 16p. Dep. CFSTI.

Subcritical neutron multiplication experiments were performed with four SNAP-19B (IRHS) heat sources containing ^{238}Pu at different array spacings in both air and water. Each source contained approximately 1 kg of ^{238}Pu, the largest quantity of this isotope ever assembled in a controlled experiment. The maximum neutron multiplication of 1.19 was obtained with the four heat sources completely submerged in water in a $^1/_8$-in. (0.3-cm) edge-to-edge planar array. (auth)

11740 (ORNL-TM-2410) IRRADIATED FUEL SHIPPING CASK DESIGN GUIDE. Shappert, L. B. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 229p. Dep. CFSTI.

The design of irradiated fuel shipping casks is governed not only by the material being shipped but also by the Regulations (AEC Manual Chapter 0529, 10CFR71 and 49CFR171-178) that impose structural performance standards on the cask by a series of postulated accidents. This Guide provides cask design procedures and criteria, developed from extensive analysis and testing programs, that enable the designer to correlate the cask design to its performance as reliably as if the cask were subjected to a physical demonstration. The Guide covers design areas of cask structural integrity, heat transfer, criticality, shielding materials of construction, and fabrication techniques. The design information presented is discussed within the framework of the AEC regulations along with the rationale and testing program that supported its development. It has been possible to provide design information in the important areas referred to in the current Regulations. However, the Regulations continue to undergo modification and reinterpretation. In consequence, future editions of the Guide will contain additional data to cover the problems that result from continuing refinement of the Regulations. (auth)

11741 IMPROVEMENTS RELATING TO MEANS FOR HANDLING NUCLEAR REACTOR FUEL ELEMENTS. Lindstaedt, Horst Karl Wilhelm (to Fairey Engineering Ltd.). British Patent 1,137,501. Dec. 27, 1968. Filed Jan. 29, 1965.

A machine is described for dismantling nuclear reactor fuel assemblies of the kind comprising a cluster of suspended pencils of fuel located by means of a skeleton locating structure incorporating spacer grids. Each pencil comprises a tubular shell (e.g., of stainless steel) and the contained fuel. One reactor type employing such a fuel cluster is the steam-generating, heavy-water-moderated power reactor. The machine incorporates means for supporting the fuel cluster with its axis vertical, a cutter mechanism, and an indexing mechanism for rotating the cluster about its axis to bring a selected fuel pencil into alignment with the cutter, the cutter mechanism being operable to sever successively the relative parts of the locating structure of the cluster. The selected pencil is withdrawn laterally from the locating structure after severance of the pencil retaining suspension. The machine includes a temporary support to receive the selected pencil when its suspension is severed and during its withdrawal. The pencil is then transferred to a container for subsequent removal from the machine. For example, the pencil may be dropped into a close-fitting elongated compartment designed to form a dashpot, whereby the free fall of the pencil in the container is retarded by the dashpot effect. When the machine is operated submerged in water, the water in the container acts as the dashpot fluid. The cutter mechanism comprises a rotary milling cutter arranged to cut away the suspension means at the top of the selected pencil, and one or more rotary cutter discs to sever the various retaining portions of the locating structure. The cutters are perferably positioned and operated under visual control, and not automatically, to ensure dismantling the cluster without damage to the fuel pencils; for this purpose a periscope is provided. A tong mechanism is used to transfer or withdraw the pencil after severance. (UK)

11742 CONTROL FOR A TRAVELLING CRANE. Bonnaure, Pierre (to EURATOM). British Patent 1,140,125. Jan. 15, 1969. Filed Mar. 29, 1966.

A device is described to speed up and alleviate the operator's job by making available to him a control system for a travelling crane such that he can control its movements by walking beside the article to be moved and pushing the control lightly in the required direction of movement. The device is specifically to provide a control system for travelling cranes used in fuel element charging and discharging in nuclear reactors. The device comprises a frame which encircles or partly encircles the article to be moved, or suspension means, and is moveable therewith. Provision is made for the orientation of the frame to a fixed reference direction to be kept constant. Inwardly directed thrust elements on the frame are responsive to the reaction of the article, or suspension means, to a displacement of the frame in a direction of movement required for the article, and the response of the element is converted into a signal to cause movement of the crane in the required direction. (UK)

11743 STANDARDS FOR THE SAFETY INSPECTION OF NUCLEAR-FUEL TRANSPORT CONTAINERS. Shisetsu, Kakou. Genshiryoku Iinkai Geppo, 13: No. 7, 34-9(July 1968). (In Japanese).

Standards for the safety inspection of nuclear fuel transport containers are given. The standards were prepared by a subcommittee within the Committee on the Safety Standards for Fabrication Facilities. The preparation of the standards were done so that the IAEA rules and regulations concerning the transport of radioactive materials are referred to and only the items on nuclear fuels materials are treated; the shipping rules for nuclear fuel and non-irradiated materials, and those for used fuels are clearly established; and the methods adopted in IAEA are utilized for confirmation of the nuclear safety of transport containers. (NSA of Japan)

11744 PROPOSED REVISED USA STANDARD [N6.1.1-1967 REV.]: NUCLEAR CRITICALITY SAFETY STANDARD FOR OPERATIONS WITH FISSIONABLE MATERIALS OUTSIDE REACTORS. Nucl. Eng. Bull., 6-1: 8p.(Jan. 1968).

Guidelines for the prevention of nuclear incidents in handling, storing, processing, and transporting fissionable materials are presented. (H.D.R.)

11745 PROPOSED STANDARD [ANS 8.4]: STANDARD FOR SAFETY IN CONDUCTING SUBCRITICAL NEUTRON-MULTIPLICATION MEASUREMENTS IN SITU. Nucl. Eng. Bull., 6-2: 4p.(Mar. 1968).

Safety criteria and practices for conducting neutron multiplication measurements on fissile material arrangements outside of specially designed experimental facilities are presented. (H.D.R.)

11746 SHIPPING CONTAINER FOR RADIOACTIVE MATERIAL. (to National Lead Co.). British Patent 1,141,871. Feb. 5, 1969. Priority date Apr. 26, 1965, United States.

A shielded container is described which is used to transport radioactive materials or spent fuel elements without permitting radiation damage to personnel who may be in the vicinity of the container and to retain the contents in the container in proper shielded position even when subjected to rough handling and shock. A safety thermal shield protects the container contents and lead shielding from heat which could occur from a fire. The thermal shield consists of a space between the outside wall and an extra wall which is filled with a lead-lithium eutectic. (F.S.)

11747 PROCESS AND APPARATUS FOR DISPOSAL OF CONTAINERS AND THEIR RADIOACTIVE CONTENTS. Calame-Longjean, A.; Palli, C.; Guillet, H. (to Commissariat a l'Energie Atomique). Canadian Patent 795,423. Sept. 24, 1968. Priority date Mar. 6, 1964, France.

A device is described for the disposal of samples of radioactive solutions and their containers after analysis. It is economical in producing a small volume of radioactive waste and is suitable for handling both solids and liquids. The process consists of a compressed air conduit for moving the polythene containers, an inclined ramp, a cooler through which liquid nitrogen is circulated, a crusher, a washing tank, and a device for conditioning solid wastes. The discarded samples are cooled to −150°C and crushed. The complete apparatus is contained in a steel-walled, leak-tight enclosure which is lead-shielded and fitted with viewing windows, handling grabs, access doors, lock chambers and lighting. (F.S.A.)

11748 POWER MANIPULATOR DEVICE. Masuyama, Katumi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1968-20576. Aug. 30, 1968. Filed Apr. 30, 1964.

A method is proposed for using the tension in a power cable to power a manipulator within a cell. The manipulator consists of a power manipulator running horizontally along rails in a cell; a power cable attached at one end of the manipulator, which runs on the rails in the opposite direction through the cell wall to the control panel; a pulley located in front of the manipulator which can travel on rollers along the same rails with the cable going through them; and a wire with one end fixed to the pulley which runs forward through a pulley on the opposed wall to a weight suspended from the pulley. (NSA of Japan)

Vacuum Engineering

11749 THE ABSOLUTE CALIBRATION OF GAUGES FOR TRITIUM GAS IN THE PRESSURE RANGE 10^{-8} TO 10^{-5} TORR. Barnes, M. R.; Gibson, A. (Culham Lab., Abingdon, Eng.). Vacuum, 18: 451-6(Aug. 1968).

A method for the absolute calibration of pressure devices for tritium is described. The method was applied to the calibration of a quadrupole mass analyzer and to a Bayard–Alpert ionization gage. The importance of any systematic errors in the calibration procedure was assessed by cross calibration (at $\sim 10^{-4}$ torr) with a McLeod gage and with a ZnS(Ag) scintillation counter which in turn is calibrated against a standard source. When absolute calibrations of a Varian quadrupole mass analyzer and a Mullard IOG 13 ion gage for tritium gas were made in the range 3×10^{-8} to 10^{-5} torr, in both cases the sensitivity was essentially constant below 10^{-6} torr. The values were 0.026 torr^{-1} for the Varian instrument ($M/\Delta M = 26$) and 5.0 torr^{-1} for the IOG 13 gage. These values differed by less than 10% from the manufacturer's data. Both instruments show a decrease in sensitivity by about 14% from this value, in the range 10^{-6} to 10^{-5} torr. Since others find no variation of sensitivity with pressure for hydrogen at pressures less than 10^{-4} torr, it is likely that the observed fall off is due to an error in the calibration procedure; however, no effect which could cause a departure of this magnitude, was detected. The internal accuracy of the sensitivities determined here was about ±1% and the measurements with the McLeod gage and scintillator suggested that any systematic errors are not greater than about 10%. (BBB)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 11443, 11714, 11900, and 13183.

General Detectors and Monitors

Refer also to abstracts 12127, 13444, and 13531.

11750 (AECL-3181) DYNAMIC RESPONSE OF A LOGARITHMIC AMPLIFIER AND A LOGARITHMIC COUNTING RATEMETER. Allen, V. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1968. 33p. Dep. CFSTI. CAN $1.00.

The logarithmic amplifier is used with ionization chambers and includes a log-rate circuit. The counting ratemeter is used with pulse counters and also includes a log-rate circuit. Calculations are made of the responses to inputs increasing exponentially and results are given for two particular instruments. Calculations are also made of the output noise of the counting ratemeter due to the random nature of the input pulses. The computer programs used are listed and the constants of the circuits that determine the dynamic response may be readily changed to obtain results for different instruments. (auth)

11751 (ANU-P-415) STATES IN ^{27}Al AND ^{89}Y USING HIGH RESOLUTION SURFACE BARRIER COUNTERS. Crawley, G. M.; Powell, D. L.; Rao, B. V. Narasimha (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1968]. 16p. Dep.

The resolution of a solid state detector was investigated and a best value of about 16 keV was obtained after cooling. The energy levels of ^{89}Y and ^{27}Al were measured with this detector. New states were observed at around 3.0 MeV and 3.7 MeV in ^{89}Y and over 20 new levels were noted in ^{27}Al. (auth)

11752 (BNWL-481-2, pp 155-200) RADIOLOGICAL PHYSICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

ATOMS—energy level lifetime measurements of proton-excited, delayed coincidence system for
PHANTOMS—neutron depth dose distribution measurements in man-equivalent
PLASTICS—radioinduced endothermic reactions in tissue-like, calorimeter for measurement of proton
PROTONS—energy straggling in thin tissue-like gases
RADIATION DETECTORS, FISSION FOIL—performance for neutron dosimetry
RADIATION DETECTORS, IONIZATION CHAMBER—design with integral switches for pulse reading
RADIATION DETECTORS, PROPORTIONAL—performance of precision long counter using boron trifluoride, in comparison to ionization chambers for neutron absorbed dose measurements
—design and performance of portable tissue-equivalent for dosimetry in mixed gamma-neutron fields
RADIATION DOSIMETERS, CALORIMETRIC—design for measurement of proton induced endothermic reactions in plastic phantoms
—design of twin-absorber, for gamma absorbed dose measurements
RADIATION DOSIMETERS, PHOTOGRAPHIC FILM—performance criteria for personnel
SPECTROMETERS—description of time-resolved, for energy level lifetime measurements of proton-excited atoms
WHOLE-BODY COUNTERS—design and calibration of portable
—use for determining potassium concentrations in muscular dystrophy patients (B.G.D.)

11753 (BNWL-SA-2045) AUTOMATIC CONVEYOR TYPE LAUNDRY ALPHA-BETA-GAMMA CONTAMINATION MONITOR. Sheen, E. M.; Crouch, G. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1967]. Contract AT(45-1)-1830. 8p. (CONF-690103-6). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Protective clothing worn by workers at Hanford in radiation zones are monitored for alpha, beta, and gamma radiation after processing in laundry facilities. Due to the large volume of protective clothing used a monitoring system consisting of scintillation detectors and a dual-wire conveyor which is both rapid and efficient was developed. (B.G.D.)

11754 (BNWL-SA-2101(Rev.)) CRITICALITY DETECTION SYSTEM: A PLEA FOR CURRENT CRITERIA. Denham, D. H.; Selby, J. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. Contract AT(45-1)-1830. 8p. (CONF-690103-5). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

A general inquiry on design criteria for reliable criticality detection and alarm systems and a review of present inefficient systems are presented. (B.G.D.)

11755 (DP-1176) FOUR-CHANNEL MONITOR FOR AIRBORNE RADIOACTIVE CONTAMINANTS. Woodward, W. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1968. Contract AT(07-2)-1. 16p. Dep. CFSTI.

An instrument was developed to monitor continuously four locations for airborne radioactive contaminants. Each monitoring channel contains five plug-in circuit boards connected to form a count rate meter with five ranges and variable time constant. (auth)

11756 (EGG-1183-1401) THE USE OF RADIOISOTOPES IN DETECTOR CALIBRATIONS. Tech Memo No. L-226. McCrary, J. H. (EG and G, Inc., Las Vegas, Nev.). Aug. 27, 1968. 13p. Dep. CFSTI.

Several possible radioisotope gamma sources for calibrating photoelectric diodes and fluor photodiodes for gamma detection are discussed. Source requirements and the experimental procedure are described. (W.H.K.)

11757 (EUR-4084) USE OF THE CHERENKOV EFFECT IN THE DETECTION AND ASSAY OF BETA-EMITTING RADIONUCLIDES IN BIOLOGICAL SPECIMENS. Camera, V.; Tanguy, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 14, 1968. 8p. (In French). Dep.

A rapid and simple method for the measurement of ^{90}Sr + ^{90}Y and ^{32}P in biological materials is described. The determinations are done on aqueous solution using the Cherenkov effect. The time required for urine analysis is about 90 min. and the sensitivity with good precision is in the range of 20 pCi of ^{90}Sr + ^{90}Y per liter and 70 pCi of ^{32}P per liter. (auth)

11758 (GA-9048) CALIBRATION AND USE OF A 5-IN.-DIAM LITHIUM GLASS DETECTOR. Neill, J. M.; Huffman, D.; Preskitt, C. A.; Young, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 2, 1968. Contract AT(04-3)-167. 44p. Dep. CFSTI.

The history of the use of a 5-in.-diam by 0.5-in.-thick ^{6}Li glass scintillator as an intermediate energy neutron detector was described. Difficulties in computing its efficiency directly were found, principally these were due to uncertainties in its composition and uncertainties in the cross sections for ^{6}Li(n,α) and possibly others. A record of the efficiency estimates used in previously published data is set forth. The detector efficiency has been calibrated experimentally over the range 50 eV to 720 keV, and this efficiency function has been extended to higher and lower energies by other means. The efficiency of the ^{6}Li glass scintillator begins to increase above 1 MeV incident neutron energy due to inelastic scattering. The detector has also been calibrated with a 5-in.-diam by $^3/_8$-in.-thick polyethylene disc immediately in front of it. The resulting efficiency was found to be increased by factors as large as three. The increase in the timing uncertainty has been computed and found to be small. The resulting efficiency curve has been found to be much less structured than that of the basic detector, and hence much more convenient for use in the study of systems having slow dieaways or having spectra containing many large resonance dips. Methods for removing gamma backgrounds present with this detector, including pulse shape discrimination and use of a depleted ^{6}Li scintillator were discussed. An alternate method which is believed to be more satisfactory was also developed. (auth)

11759 (ORNL-tr-2069) A STUDY OF ELECTRON-PHOTON SHOWERS WITH SCINTILLATION COUNTERS. Zaimidoroga, O. A.; Kut'in, V. M.; Prokoshkin, Yu. D.; Tsupko-Sitnikov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P1-3976. 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 46310.

11760 (PINSTECH/PHY-16) THEORETICAL CALCULATION OF THE LOW ENERGY EFFICIENCIES OF CYLINDRICAL Ge(Li) DETECTOR. Ahmad, A. A. Z.; Ahmed, N. M. (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). May 1968. 20p. Dep.

Efficiencies for a cylindrical Ge(Li) detector for gamma rays were calculated theoretically. An IBM 1620 computer was used for obtaining numerical values. Efficiencies were found for different sizes of the detector and also for different values of source-to-crystal distance and energy. (auth)

11761 (RT/EL-(68)11) n-p JUNCTION OBTAINED IN SILICON BY MEANS OF ION IMPLANTATION. Ascoli, S.; Fioroni, F.; Fiori, D.; Gislon, R.; Papa, C.; Rispoli, B.; Spoglia, U. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 23p. (In Italian). Dep.

A study on the preparation of semiconductor detectors by the doping technique is being undertaken at Casaccia. The preliminary results obtained in the study are reported. The tests described showed that during the irradiation of Si foils with $^{11}B^+$ and $^{31}P^+$, an n-p junction is created. The measurement of the resistivity of the foil permitted the growth of the concentration profile of the impurity injected to be followed. The profile can be interpreted in various ways, of which the most plausible at the moment is that of an amorphous-type penetration associated with a double canalization effect. (J.S.R.)

11762 (UCRL-71362) PLUTONIUM SURVEY WITH AN X-RAY SENSITIVE DETECTOR. Tinney, J. F.; Koch, J. J.; Schmidt, C. T. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 15, 1969. 26p. (CONF-690103-4). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Traditionally, plutonium surveys have been conducted with alpha-sensitive detectors. More recently, however, x-ray detectors have been developed for this purpose. The design and performance of the low-energy x- and gamma-ray detector developed at LRL for plutonium survey are described. The results of a plutonium survey conducted under field conditions with this detector and a conventional alpha survey instrument are also presented. (auth)

11763 MEASUREMENT OF GAMMA AND NEUTRON COMPONENTS IN MIXED FIELDS WITH PLASTIC SCINTILLATORS. Baroni, E. E.; Viktorov, D. V.; Kilin, S. F.; Rozman, I. M.; Shoniya, V. M. (Physical-Technical Inst., Sukhumi, USSR). Prib. Tekh. Eksp., No. 5, 70-2(Sept.-Oct. 1968). (In Russian).

A method was proposed for measuring gamma and neutron components in mixed radiation fields. The method uses the difference in relation to specific quantities of scintillations for electrons and protons in certain plastic scintillators. Results are given on the performance of the detector in mixed fields, and the possibility of using it for the dosimetry of fast neutrons is discussed. (tr-auth)

11764 LIQUID SCINTILLATORS BASED ON MACHINE BUILDING OILS. Zemskova, I. I.; Zhiltsova, L. Va.; Tyminskii, V. G. (All-Union Scientific Research Inst. for Standardization and Machine Construction, Moscow). Prib. Tekh. Eksp., No. 5, 75-6(Sept.-Oct. 1968). (In Russian).

The light yield of liquid scintillators, which was prepared on the basis of machine-building oils in a series of cases was compared with standard scintillators. The optimum concentration of activator impurities was given. The efficiency of the scintillators was shown to constitute up to 60% of the amplitude of a stilbene crystal. It is noted that scintillators prepared with quality oils are explosion-proof, economical, and nontoxic. (tr-auth)

11765 NUVISTOR PREAMPLIFIER FOR SEMICONDUCTOR DETECTORS. Radionov, Yu. F.; Shiryaev, V. S. Prib. Tekh. Eksp., No. 5, 81-3(Sept.-Oct. 1968). (In Russian).

A low-noise charge-sensitive preamplifier for semiconductor detectors, using a subminiature metalloceramic nuvistor is described. Electronic diagrams, assembly plans, and the operating characteristics are included. At normal noise levels the resolution is 1 kv at fwhm and time constant is $\tau = 1$ microsecond. (tr-auth)

11766 REFERENCE SIGNALS ON BASIS OF ELECTROLUMINESCENT DIODES FOR SCINTILLATION COUNTERS. Omelyanenko, M. N.; Tyupikov, V. K.; Filchenkov, V. V. Prib. Tekh. Eksp., No. 5, 177-9(Sept.-Oct. 1968). (In Russian).

A generator of calibrated light signals based on electroluminescent diodes of SiC and GaP for scintillation spectrometers is described. The duration of the light flashes was 0.5 to 1.0 microseconds and the rise time was 0.1 – 0.2 microseconds. The brilliance of the flash is regulated in the range corresponding to the amplitude of the scintillations upon recording of neutrons with energies at 1 to 15 MeV. The temperature instability was compensated and can constitute less than 0.2%/°C. (tr-auth)

11767 THE APPLICATION OF THE KFL-2 IONIZATION CHAMBER FOR THE MEASUREMENT OF STRONG VACUUM ULTRAVIOLET RADIATION. Khrushch, B. I.; Dmitriev, A. B.; Lyulichev, A. N. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 5, 188-90(Sept.-Oct. 1968). (In Russian).

The operating characteristics of the KFL-2 ionization chamber, during irradiation with strong vacuum ultraviolet radiation from a hydrogen lamp, showed that for currents of 0.1 to 5 microamperes, the I–V characteristics are not saturated. In this case, with an increase of radiation the sensitivity of the chamber is reduced. Upon measurement of stronger radiation fields a calibrated wire-mesh attenuator is recommended to decrease the radiation interacting with the chamber, in order to obtain currents of $10^{-6} - 10^{-9}$ amperes. In addition, the I–V characteristics of the chamber, its plateau and sensitivity remain constant. (tr-auth)

11768 IONIZATION CURRENT FISSION CHAMBER WITH NONBURNABLE RADIATOR. Malyshev, E. K. Prib. Tekh. Eksp., No. 5, 61-3(Sept.-Oct. 1968). (In Russian).

The design characteristics of an ionization current fission chamber with a nonburnable radiator are described. (tr-auth)

11769 SILICON DETECTORS FOR RECORDING PULSED BEAMS OF GAMMA RADIATION. Kireev, P. S.; Arkhangelskii, I. A.; Bespyatov, Yu. D.; Brusov, Yu. A.; Vyunskovskaya, V. I.; Gavrilovskii, B. V.; Koltsov, G. I.; Mitin, V. I. Prib. Tekh. Eksp., No. 5, 63-5(Sept.-Oct. 1968). (In Russian).

The properties of silicon semiconductor detectors, used for the recording of gamma radiation, are described. The area of the crystal is 0.25 cm^2, the thickness of the depleted layer is 200 to 300 μ, and the sensitivity is approximately 2×10^{-17} amp sec cm^2/MeV and resolution of 3 – 5 nanoseconds. (tr-auth)

11770 END-WINDOW COUNTER WITH SECURED ANODE. Shlyagin, K. N.; Savelev, G. I. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp., No. 5, 65-6(Sept.-Oct. 1968). (In Russian).

An end-window counter with the anode rigidly attached to a fiber of insulating material stretched across the diameter of the window is described. The anode of such a counter does not undergo deformations and vibrations inherent to anodes with a glass bead. This strengthening of the anode permits the fabrication of larger dimension end-window counters for spectrometry of x rays and soft gamma rays with negligible losses of working volume and energy spectra deformation. (tr-auth)

11771 AUTOMATIC COMPENSATION OF GAMMA BACKGROUND IN BETA DETECTION. Petushkov, A. A. (Inst. of Hygiene and Preventive Medicine, Moscow). Prib. Tekh. Eksp., No. 5, 67-9(Sept.-Oct. 1968). (In Russian).

A method was described for automatic compensation of gamma background during measurements of beta particles in the presence of gamma fields. The method is based on the use of scintillation detectors and electronic circuits for pulse shape discrimination. Results of tests on a model of the apparatus were given. (tr-auth)

11772 THE PARAMETERS OF SCINTILLATORS FOR THE DISCRIMINATION OF NEUTRONS AND GAMMA RAYS ACCORDING TO PULSE SHAPE. Grudskaya, L. E.; Poduzhailo, V. F.; Tsirlin, Yu. A. (All-Union Scientific Research Inst. of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 5, 73-5(Sept.-Oct. 1968). (In Russian).

The results of experiments, using liquid scintillators for discrimination of neutrons and gamma rays according to pulse shape, which emerge from reactions using the cyclotron of the Institute of Atomic Energy, are presented. (tr-auth)

11773 HIGH-EFFICIENT 4π-PROPORTIONAL LOW LEVEL COUNTER FOR X-RAY SOURCES. Wahlen, M.; Oeschger, H. (Univ., Bern). Nucl. Instrum. Methods, 66: 193-6(Dec. 15, 1968).

For radioactivity measurements of cosmic dust particles in deep sea sediment cores and polar ice, especially ^{53}Mn (EC, αKL 5.4 keV, half-life 2×10^6y) and ^{59}Ni (EC, αKL 6.9 keV, half-life 7.5×10^4y), a low level proportional X-ray counter in 4π-geometry has been developed. The detector operates as a gas flow counter (argon and methane up to 10 atm) and is provided with internal and external anticoincidences. The background in the energy region of ^{53}Mn and ^{59}Ni is 0.005 cpm/halfwidth and 0.007 cpm/halfwidth respectively for 30 cm^2 area (4π). (auth)

11774 APPLICATION OF TIME-VARIANT FILTERS TO TIME ANALYSIS. Douglass, T. D. (ORTEC Inc., Oak Ridge, Tenn.); Williams, C. W.; Pierce, J. F. Nucl. Instrum. Methods, 66: 181-92(Dec. 15, 1968).

Timing with semiconductor nuclear radiation detectors, particularly Ge(Li) detectors, is increasing in importance in the field of nuclear research. In determining the time of occurrence of a nuclear event from such a detector, the present limitation by current timing methods is charge collection variations in the detector. The ultimate limitation of timing uncertainty, however, in any semiconductor detector is given by the ratio of noise to signal slope at the point of discrimination. For a minimum value of timing error, therefore, a low noise level and fast rise time signal are necessary. Lowest noise and fastest rise time are contradictory requirements; and therefore, an optimum filter and a minimum timing error can be determined. The optimum filter is normally non-realizable; however, the minimum timing error associated with the optimum filter provides a good basis for comparison of realizable filters. For a given noise spectrum and signal spectrum, an examination of the effect of certain relizable filters on timing error is presented. The filters included are RC low-pass, RC high-pass, and the combination of RC low-pass, RC high-pass. Both the time-invariant and time-variant cases were examined, and theoretical data are compared for each case indicated to demonstrate the advantages of the time-variant filter for timing. The advantages of the time-variant filter are lower discriminator levels, allowing the reduction of the effect of charge collection variations on timing error, and lower noise/slope error at low discriminator levels. A time measurement on 511 keV gamma rays using a 20 cm^3 coaxial Ge(Li) detector and time-variant filtering on the preamplifier output signal resulted in a timing error spectrum with fwhm equal to 5.63 nsec and fw(0.1)m equal to 10.58 nsec. (auth)

11775 CORRELATION ANALYSIS OF LOW-FREQUENCY NOISE OF SURFACE-BARRIER SEMICONDUCTOR DETECTORS. Escudie, B.; Balland, J.-C.; Chery, R. (Univ., Lyon). Nucl. Instrum. Methods, 66: 355-6(Dec. 15, 1968). (In French).

Using correlation method and Fourier transform spectral analysis of low frequency components of semiconductor noise is now feasible. With this method relaxation times of p-n detectors have been measured, giving new data for optimum filter synthesis. (auth)

11776 DEAD-TIME CORRECTIONS IN DETECTION EXPERIMENTS ON NUCLEAR STATISTICS. Madero, C. Castro; Corcuera, R.; Schilman, H. (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Instrum. Methods, 66: 270-6(Dec. 15, 1968).

Dead-time corrections to be applied in nuclear detection experiments are obtained. A probabilistic analysis of the problem is made, starting from the different possible states of a detection system. The correlations present in the count loss are avoided comparing probabilities of different states if the time intervals are suitably choiced. The formalism is then applied to the two most important statistics in nuclear detection: Poisson Statistics and Negative Binomial Statistics. Application to some experiments as the α-Feynman of neutron correlations is straightforward. The accuracy of the expressions was verified experimentally in Poisson distribution experiences and proved to fit it very well through the chi-square test. This also proved the present one to be better than Pacilio's formulation. Finally the parameter p of correction was determined experimentally for a big number of conditions and the results showed the goodness of the theoretical hypotheses. (auth)

11777 ABSOLUTE CALIBRATION METHOD FOR DETECTION EFFICIENCIES OF HIGH-ENERGY GAMMA RAYS. Mausberg, W.; Hofmann, K.; Tauber, M. (Univ., Freiburg i. B.). Nucl. Nucl. Instrum. Methods, 66: 289-92(Dec. 15, 1968).

An experimental method for the determination of absolute γ ray detection efficiencies in the energy region up to about 20 MeV is discussed. The method is based on a coincidence measurement and follows the principle of the well known sample calibration method. A nuclear reaction is used for generating the high-energy radiation. As an example, the efficiency of a 6″ dia. × 8″ NaI(Tl) crystal for 12 MeV has been determined by means of the $^{11}B(p,\gamma)^{12}C^*$-4.44 MeV reaction. (auth)

11778 A CRYOSTAT FOR Ge(Li)-DETECTORS WITH INTERNAL LIQUID CIRCULATION AND A SWIVELLING COLD FINGER. Fleck, C. M.; Niederstaetter, W. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods, 66: 304-8(Dec. 15, 1968).

In the cold finger cryostat being described here, a circulation of the cooling medium takes place in the cold finger. This results in short cooling times and low cooling agent consumption. Furthermore, the cold finger may be turned around along a conical path. (auth)

11779 PROPORTIONAL COUNTER WITH AUTOMATIC GAIN CONTROL. Brinkman, A. C.; De Groene, P. (Space Research Lab., Utrecht). Nucl. Instrum. Methods, 66: 316-20(Dec. 15, 1968).

In aid of a solar x-ray experiment aboard the earth satellite ESRO-II a proportional counter was developed, at the Utrecht Space Research Laboratory, of which the gas gain can be monitored. There are different factors that can influence the gas gain of a proportional counter, of these the gas pressure and supply voltage are the most important. The electronic circuitry that makes use of this monitor voltage to control the high voltage supply of the proportional counter so that a constant output pulse height distribution of the x-ray detector can be achieved is discussed. (auth)

11780 MUONIC X-RAY EFFICIENCY CALIBRATION OF A GERMANIUM-LITHIUM DRIFTED DETECTOR. Pratt, T. A. E. C. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Instrum. Methods, 66: 348-50(Dec. 15, 1968).

Efficiency calibration of a Ge-Li detector using muonic x-rays from targets of various proton content is being discussed. After appropriate corrections a least-squares fit was made to the energy region 296 keV-3435 keV. The ratio of K_α muonic X-ray to all muonic K X-rays is also reported. (auth)

11781 METHOD FOR COPPER-STAINING GERMANIUM CRYSTALS. Rivet, E. J. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 67: 349-51(Jan. 15, 1969).

A method for copper-staining germanium crystals is described. This method can be used to show nonuniformities in germanium crystals prior to Li drifting, and as a tool for studying the diffusion and drifting of Li in germanium. (auth)

11782 A SELECTIVE AND VERSATILE LOW LEVEL BETA-, X-, AND GAMMA-RAY DETECTOR ASSEMBLY. Bhandari, Narendra (Univ. of California, San Diego, La Jolla). Nucl. Instrum. Methods, 67: 251-6(Jan. 15, 1969).

By incorporating various features of the well known Geiger, proportional and scintillation counting in a single system, a low level detector for measurement of $\beta^{\pm}$-, X- and γ-radiation has been developed. The system can be operated in five different modes to suit the decay scheme of the radionuclide under study. It is specially suited for an unambiguous identification of radionuclides which emit β/X rays in coincidence with γ radiation where a background of the order of 10^{-3} cpm has been achieved. To illustrate the merit of this system the case of radioactivities in meteorites is considered where, when coincidence measurements are possible, the sample requirement reduces significantly over the counting devices now in practice. Specific cases are discussed which show that about a dozen useful radionuclides can be measured in a stone meteorite sample of less than 30 g including ^{22}Na and ^{26}Al in 5 g, and ^{53}Mn in mg quantities. The limited data available so far permit the evaluation of the contribution of some of the sources to the residual background of the detector. (auth)

11783 LEADING-EDGE TIME PICKOFF CIRCUIT. Kinbara, S.; Kumahara, T. (Japan Atomic Energy Research Inst., Ibaraki). Nucl. Instrum. Methods, 67: 261-6(Jan. 15, 1969).

The circuit described in this paper can accurately define the time at leading-edge of pulses from radiation detectors. The basic circuit consists of two input shaping networks and an amplitude comparator generating output pulse having a fixed time almost independent of input pulse height. The output pulse shifts only ±0.5 ns when the input having risetime range of 0.1 to 0.5 μs is varied from 0.25 to 10 V in amplitude. (auth)

11784 A DETERMINATION OF THE RELATIONSHIP BETWEEN EFFICIENCY AND VOLUME OF A Ge(Li) DETECTOR AND A PROPOSED EDDY CURRENT TECHNIQUE FOR DEPTH TESTING THE p-i-n CONTOURS OF THE CRYSTAL. Walford, G. V.; Doust, C. E. (Univ. of Surrey, London). Nucl. Instrum. Methods, 67: 272-6(Jan. 15, 1969).

A study was made of the variation of active volume and full peak efficiency of Ge(Li) detectors. It was found that only high resolution detectors had the expected high efficiencies. Also an eddy current technique is proposed for investigating the internal variation of the p-i-n contours.

11785 PLASMA EFFECTS AND CHARGE COLLECTION TIME IN SOLID STATE DETECTORS. Taroni, A. (Univ. of Modena, Italy); Zanarini, G. Nucl. Instrum. Methods, 67: 277-82(Jan. 15, 1969).

The effect of slowing down of charge collection due to the plasma situation created by strongly ionizing particles incident on a solid state detector is theoretically examined. The mathematical formulation of the problem leads to a system of partial differential equations which is numerically solved. The theoretical provisions obtained in this way for different detectors and for various ionizing particles and temperatures are in fine agreement with the experimental results. (auth)

11786 DETECTION SYSTEM FOR PHOTONEUTRONS USING A LARGE SCINTILLATOR CAPABLE OF ANALYZING SIMULTANEOUSLY THE REACTIONS (γ,xn). Beil, H.; Bergere, R.; Veyssiere, A. (CEN, Saclay, France). Nucl. Instrum. Methods, 67: 293-304(Jan. 15, 1969). (In French).

A method is given to determine the distribution of all possible angles in a counter telescope, due to the finite geometry. (auth)

11787 APERTURE FUNCTION OF A COUNTER TELESCOPE. Franz, D. J. (Albert-Ludwigs-Univ., Freiburg i. B.). Nucl. Instrum. Methods, 67: 323-4(Jan. 15, 1969).

A detection system capable of analyzing simultaneously (γ,n), (γ,2n), (γ,3n) and (γ,4n) interactions is described. The photoneutron detector is a 1 m dia. sphere containing a gadolinium-loaded liquid scintillator viewed by eight photomultipliers. The essential characteristics of the detector, as adapted to this specific photonuclear work, such as neutron detection efficiencies, time distribution of neutron capture probabilities and pile-up probabilities are discussed. Experimental and theoretical results concerning these parameters show reasonable agreement. The main disadvantage in this type of detector is its high background sensitivity. The physical and electronic means used to obtain the best signal-to-noise ratio are also discussed. The mathematical data analysis required to convert the rough experimental data into the different photonuclear cross sections $\sigma(\gamma,xn)$ is described, and the partial photoneutron cross sections of ^{181}Ta are given as an example. (auth)

11788 RESTRICTED ENERGY LOSS CRITERION FOR REGISTRATION OF CHARGED PARTICLES IN PLASTICS. Benton, E. V.; Nix, W. D. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 67: 343-7(Jan. 15, 1969).

It was found that the restricted energy loss rate of charged particles can be used as a convenient criterion to predict the formation or non-formation of etchable tracks in plastics. The criterion allows sensitivity assignments, in absolute units, to each of the polymeric detectors. An experimentally determined parameter indicates that only electron energy transfer collisions of about 1.0 keV and less are important in track formation. The criterion is consistent with the known experimental observations of charged particle registration in plastics. It is proposed that latent (etchable) tracks are formed when the energy density (dose) in the immediate vicinity of the particle trajectory exceeds a critical value that is characteristic of the particular detecting material and the specific etching conditions. (auth)

11789 DESCRIPTION OF A METHOD OF ANALYSIS OF THE CHARGED PARTICLE SPECTRA OBTAINED IN NUCLEAR REACTIONS AT LOW ENERGIES. Dumazet, G.; Rihet, Y. (Institut d'Etudes Nucleaires, Algiers). Nucl. Instrum. Methods, 67: 205-12(Jan. 15, 1969). (In French).

A scanning method for an IBM computer is described for charged particle spectra obtained in nuclear reactions at low energies and in particular transfer reactions. This method is composed of the following steps: background subtraction, spectra smoothing when statistics are considered to be low, identification of the peaks, their separation when they overlap, and their summation. The whole method permits to obtain rapidly experimental results with a higher precision than 5%. (auth)

11790 COMPUTATION OF CHANNELS RATIO IN LIQUID SCINTILLATION COUNTING. A THEORETICAL CONSIDERATION. Peng, C. T. (Univ. of California, San Francisco). Anal. Chem., 41: 16-21(Jan. 1969).

A semi-empirical method is given for computing channels ratio in quench correction in liquid scintillation counting from two parameters k and γ, which are ratios of integral count rates obtained from quenched and unquenched homogeneous samples using the discriminator levels defining the channel width as base lines. In addition, a procedure for adjusting instrument settings to given channels ratio is outlined. The use of parameters k and γ is advantageous in allowing sensitive adjustment in operating conditions to be made to achieve optimal correlation of counting efficiency with channels ratio and also in permitting interrelation of correlation curves obtained on different spectrometers. (auth)

11791 INFLUENCE OF LATENT IMAGE FADING IN QUANTITATIVE RADIOAUTOGRAPHY. Baumbach, H.; Hartmann, G. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 4: 435-7(Nov. 1968). (In German).

The effects of temperature and relative humidity and of the time between exposure and development were determined for the films AF 3, AF 4, AF 66, and the plates K 106, Kodak AR 10, and ORWO Np 18. The fading was a linear function of the time except for AR 10 at 20 and 30°C. There was a significant effect of the temperature and moisture content of the air. In the case of ORWO materials refrigeration at 4°C makes the fading negligible during storage. (J.S.R.)

11792 SOME MEASUREMENTS BY MEANS OF THE SOVIET LARGE-AREA COUNTER SBT-10. Michel, H.-St.; Deckert, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Isotopenpraxis, 4: 438-41(Nov. 1968). (In German).

The SBT-10 counter for the registration of β particles contains 10 chambers which can be connected and disconnected at will. The characteristics of the chamber are tabulated. The use of the chamber for pulse measurements and pulse coupling over antennas is described. The application of a common working voltage for all counter chamber for elimination of post-discharge is shown. (J.S.R.)

11793 CALIBRATION OF AN IONIZATION CHAMBER FOR INTERNAL GAS COUNTING. Bestetti, M. E.; Sangiust, V.; Terrani, S. (CESNEF, Milan). Energ. Nucl. (Milan), 16: 41-7(Jan. 1969).

The calibration and characteristics of an ionization chamber used to monitor β emitting gases are described. The efficiency of the chamber was determined by studying the variation of the current with the pressure of the filling gas. A curve is shown which gives the sensitivity of the chamber i.e., the current per μCi/cm^3 as a function of the average β energy. (auth)

11794 CONTRIBUTIONS TO THE STATISTICS OF TIME MEASUREMENTS BY THE SCINTILLATION METHOD. Yakushin, V. V. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 95-155(1968). (In Russian).

The application of scintillation and Cherenkov-type counters for studying nuclear events by the coincidence method is reviewed. Recording of nuclear events by coincidence is used to obtain information on the spatial and time correlation of the products of interaction. The time correlation is needed specially to determine the genetic interrelation of these products, such as the time of life of excited states, the half-life of short-lived radioisotopes, etc. It allows to determine the simultaneous nature of emission of the nuclear interaction products by the target or nature of their succession. The study revealed that the nuclear particles are recorded after a series of processes take place in the counter. These processes, which may be described by experimental functions, include energy release of the particles in the scintillator, excitation and extinction of luminescence centers, propagation of the light to the photocathode of the photomultiplier from the sensitive region, collection of photoelectrons on the first emitter and of the secondary electrons of the subsequent emitters, etc. It was found that there is a definite correlation between the resolving abilities of the counter,—the fwhm of the prompt coincidence curve, and the time resolution of the coincidence system in one of the channels. In experiments with slow statistics of collection, when the nuclear particles are recorded with maximum efficiency ($\geq$0.95%) the resolving ability and the time resolution agree. In fast statistics experiments, the resolving ability of the counter approaches the limiting value. The results are helpful to design experiments for recording low-energy particles. (Review article, 58 refs). (TTT)

11795 CATHODE CASCADE WITH AMPLIFIED FEEDBACK AND ITS APPLICATIONS. Yakushin, V. V. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 156-91(1968). (In Russian).

The cathode cascade with amplified feedback—also called White's cascade—is an improved version of the cathodic load cascade, has a much lower output resistance at lower frequencies than the cathode repeater. Increase of the anodic load enhances this advantage of the cascade, but its high-frequency characteristics reach a maximum. A correct choice of the parameters of White's cascade allows to broaden its field of application and to improve the performance of radiotechnical devices. By replacing cathode repeaters with White's cascade it may be possible to broaden the transmission band of the RC chain, used as the load, to improve the recording of nuclear particles by scintillation counters, and to increase the stability and the depths of the feedback. The results obtained may be applied to any tube except triodes. The general recommendations derived from the analysis allowed the choice of characteristics which guarantee uniform transitional features of the cascade with a minimum growth time. It was found that a too strong over compensation of the cascade which improves its low-frequency characteristics, results in the worsening of the high-frequency properties. The theoretical and experimental data agree up to growth time of the order of a few nanoseconds. (TTT)

11796 THE ABSOLUTE SENSITIVITY OF A THICK-WALLED, GRAPHITE IONIZATION CHAMBER FOR UP TO 1-GeV PHOTONS. Usova, I. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 85-94(1968). (In Russian).

Use of thick-walled ionization chambers for measuring the energy flux in a high-energy, γ-radiation beam is based on the extension of the application of small chambers to cases in which the free path of secondary electrons generated by the photons in the walls is larger than the thickness of the front wall. This results in the disturbance of the equilibrium between the primary and secondary reactions near the cavity. However, if the path of secondary electrons is smaller than the thickness of the front wall, the energy involved ionization is the same as the energy of the generated secondary electrons. The difference was found to amount to only 2.2% which indicates that the thick-walled chambers may be used for measuring the absolute radiation intensity in electron accelerators. (TTT)

11797 DETECTOR OF THE STOPPAGE OF POSITIVE PIONS. Aleksandrov, Yu. M.; Grushin, V. F.; Leikin, E. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 80-4(1968). (In Russian).

In the ~100-MeV region, the recording of positive pions involves separation of the particles by slowing them down to complete stoppage, and making use of the decay of the stopped pion: $\pi \rightarrow \mu + \nu$. A detector for the stopped pions was developed on the basis of these reactions in order to identify them. The system included a telescope of scintillation counters separated by attenuating filters. The positive pions of a given energy were determined by separating the particles which had an ionizing path within the boundaries of one of the counters. On these bases the $\pi \rightarrow \mu$ decays were selected, obtaining exponentially delayed events with a time constant of $\tau_\pi = 2.55 \times 10^{-8}$ sec, the time of life of a pion at rest. The method was used for investigating $\gamma_p \rightarrow n\rho^+$ reactions near the threshold energy of the γ quanta and to measure the pion yield under very small angles, whereby ~10^5 positrons passed through the detector for each stopped pion. (TTT)

11798 RECENT ADVANCES IN INSTRUMENTATION FOR URANIUM SEARCH. Stewart, J. R. At. Energy Aust., 11: No. 4, 25-30(Oct. 1968).

Three techniques used for uranium prospecting are discussed. These techniques are gamma spectrometry, radon surveys, and trace-element surveys. (B.G.D.)

11799 DISTRIBUTION OF ABSORBED BETA ENERGY IN SOLID MEDIA. Cross, W. G. (Atomic Energy of Canada, Ltd., Chalk River). Can. J. Phys., 47: 75-84(Jan. 1, 1969).

Distributions of absorbed beta energy around a point source in Al and $C_{19}H_{21}$ plastic have been measured, with an extrapolation chamber, for seven emitters with endpoint energies from 0.16 to 3.55 MeV. In contrast with previous measurements made with plane solid absorbers, the shapes of the distributions at short distances are quite different for low- and high-energy emitters and the distributions for low-energy emitters are in agreement with those measured in gases. Dose distributions in Al and $C_{19}H_{21}$ have the same shapes. The distance scaling factors relating these distributions to that in air are 1.04 ± .01 for $C_{19}H_{21}$ and 1.00 ± .01 for Al, and are independent of beta energy to within 1%. All of these results agree with calculations based on the theory of Spencer. (auth)

11800 COUNTING OF ^{32}P-LABELED RIBONUCLEIC ACID UTILIZING CHERENKOV RADIATION. Mizuno, Shigeki; Eguchi, Hoshio; Yano, Keiji; Yamaguchi, Hikoyuki (Tokyo Univ.). Radioisotopes (Tokyo), 18: 19-25(Jan. 1969).

^{32}P-labeled RNA was quantitatively counted via Cherenkov radiation, without adding any scintillator solvent, using a liquid scintillation spectrometer. This method could be applied to the counting of ^{32}P-RNA of high molecular weight form or hydrolyzed form either in solution or adsorbed form on a filter-paper. The counting efficiency, approximately 20% in solution, was practically not affected by acids, alkalis, salts, sucrose, protein, and carrier RNA. The sample volume was shown to be a factor which affected the counting efficiency. (auth)

11801 PARTICLE ENERGY ESTIMATES > 10^{10} eV: TECHNIQUES FOR IMPROVING THE ACCURACY AND EXTENDING THE USEFUL ENERGY RANGE OF MULTIPLE SCATTERING MEASUREMENTS. Bertsch, David Lemont. St. Louis, Washington Univ., 1968. 255p.

Thesis.

The scattering procedure for measuring particle energies is critically examined and methods are proposed, particularly in regard to the reduction and detection of noise, and to its statistical removal from the Coulomb signal in order to improve the quality of scattering measurements and to show that reliable observations can be achieved well above the level of 5×10^9 electron volts per nucleon. Following a brief introduction, the Moliere theory of small angle multiple scattering is reviewed. Recent refinements in the theory are incorporated in a new calculation of the scattering constants for second difference characteristics in emulsions. Approximation methods are derived wherein scattering constants for other characteristics can be related to the known values. The various sources of noise and its effect on the Coulomb signal are studied. The same mathematical formalism used to study Coulomb scattering is employed to study the statistical properties of stage noise and spurious scattering. The first arithmetic moment for spurious scattering is found to have two components; one that varies with cell size like stage noise, $\propto s^{1/2}$, and a second that varies with cell size much like a Coulomb signal. The observable signal is shown to be distributed according to a Moliere distribution whose first arithmetic moment differs slightly from the customarily assumed quadratic sum of the component signals. An improved method is described which utilizes the distinguishable properties of the Coulomb and noise signals to estimate the total noise from the observed signals at different cell sizes. A spurious scattering signal that is similar to the Coulomb signal does not respond to this or any noise analysis. To determine the extent of this type of noise, an experimental study of the scattering of 21.0 GeV/c pions was made. This experiment shows that spurious scattering in the emulsions used for this study is very low and should present no difficulties for energies up to at least 40 GeV. It is suggested that such low levels of spurious scattering result from the use of glass-backed emulsions, developed isothermally at low temperatures. The pion experiment also furnishes a critical test of the noise detection and correction procedures. Even when spurious scattering can be neglected, other noises may significantly reduce the statistical significance of a measurement. One method for improving the signal-to-noise ratio is introduced. A modified difference characteristic based on the average of the corresponding differences from several repeated measurements is studied in detail. It is found that each noise source is reduced more than the Coulomb signal by this averaging. Experimental results are given to demonstrate the effectiveness of this technique and to show that measurements to energies of at least 20 GeV/nucleon are feasible. (Disser. Abstr.)

11802 NUCLEAR ELECTRONICS: CHARGE-SENSITIVE AMPLIFIER WITH A FAST TIMING SIGNAL. Lauch, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Kerntechnik, 10: 683-6(Dec. 1968). (In English and German).

A low-noise charge-sensitive amplifier is described, which is used as a standard unit for Si semiconductor detectors. The signals are amplified up to a maximum of ±10 V, and pulse shaping is possible. The energy resolution with pulse shaping ($\tau = 2$ μs) is 2.5 keV + 0.055 keV/pF. In addition, a fast timing signal with zero crossing is generated for coincidence and time-of-flight measurements. With a sufficiently low detector capacitance the timing signal can be used for triggering down to about 100 keV. (auth)

11803 PARAMETERS AND APPLICATION OF SILICON SEMICONDUCTOR DETECTORS. Silar, J. (Research Inst. for Nuclear Instruments, Brno). Jad. Energ., 14: S1-15(Dec. 1968). (In Czech).

The application possibilities of silicon semiconductor detectors are evaluated on the base of recent literature data. The base parameters, the attained values, and the problems of further improving these detectors are reported also. A list of 155 references is included. (auth)

11804 END WINDOW G-M SURVEY METER (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1815). 7 drawings.

A G-M survey meter equipped with an end window for detecting low-energy beta particles is described. The instrument works with the Amperex 500 V series radiation counter tube. It has low battery consumption and is light in weight. Calibration shifts less than 2% over the life of the rechargeable battery. A single calibration control allows the instrument to be calibrated after the counter tubes are changed. A dc lock-in circuit ensures full-scale indication in a strong radiation field that could analyze or jam the pulse circuitry. (For details see TID-4100 Suppl. 50.) (F.S.)

11805 A STANDARDIZED METHOD FOR MAKING NEUTRON FLUENCE MEASUREMENTS BY FISSION FRAGMENT TRACKS IN PLASTICS. A SUGGESTION FOR AN EMERGENCY NEUTRON DOSIMETER WITH RAD RESPONSE. Pretre, S.; Tochilin, E.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco). pp 491-505 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A neutron detector is described which consists of a fission foil (^{232}Th, ^{235}U, ^{238}U, ^{237}Np or ^{239}Pu) in contact with a plastic track detector. These detectors were exposed to reactor neutrons and to monoenergetic neutrons with energies between 1.0-18 MeV.

Fission fragment tracks registered in the plastic were selectively etched by a hydroxide and counted in an optical microscope. For thick foils of fissionable metals the sensitivity of the system was found to be (1.16 ± 3%) × 10^{-5} fission fragment tracks/neutron · barn which is in good agreement with theoretical calculations. This sensitivity is independent of the fissionable element used, independent of the neutron energy, fairly independent of the material chosen for tracks registration (plastics, glass, mica) and of etching conditions. Since the (n,f) cross sections are accurately known for most neutron energies, the above constant can be used for standardized measurements of neutron fluences. An application to emergency neutron dosimetry is suggested. The fissionable material must be readily available and have low specific activity while the (n,f) reaction cross section should follow the Rad/n/cm^2 curve for tissue. As first compromise, natural thorium is suggested to measure the "proton-part" of the neutron dose (above 1 MeV). The second compromise is an alloy made of natural thorium and 0.5% (by weight) of natural uranium. Using the technique of track counting, these dosimeters have a practical range between 5 and 30,000 Rad. To avoid track counting, a direct readout method using thin Mylar film was investigated. This plastic is opaque in the deep ultraviolet (below 3000 Å), and the etching of fission fragment tracks in this plastic film produces holes. Neutron dose is determined by the amount of uv light passing through the etched film. (auth)

11806 SOME APPLICATIONS FOR SEMICONDUCTOR DETECTORS IN HEALTH PHYSICS. Lippert, J. (Risoe Research Establishment, Roskilde, Denmark). pp 271-7 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920—(Vol.1).

Continuing earlier detector development, a small group in the Health Physics Department started work in the semiconductor detectors field in 1963, with a feeling that these might be valuable for spectrometry as well as low level counting. Germanium detectors, which are produced in sizes up to 9 cm^2 at the time of writing (March 1966), are discussed. An attempt to make a well-type detector is to be done presently and results will be reported. Some of our detectors are in use in health physics applications, such as fallout measurements (^{57}Co, ^{155}Eu, ^{134}Cs, etc.), identification of components of contaminations and tracer techniques in studies of filter efficiencies. Some examples are reviewed. (auth)

11807 POSITION-SENSITIVE PROPORTIONAL COUNTER. Scobie, J. (Pennsylvania State Univ., University Park). Amer. J. Phys., 37: 107(Jan. 1969).

As part of an experiment on the operation and uses of gaseous detectors, devised for a new undergraduate laboratory course in nuclear engineering, a proportional counter has been constructed which relies on the detection of the light emitted in the counter discharge to provide a position-sensitive signal. (B.G.D.)

11808 HEALTH PHYSICS INSTRUMENTATION. Barnes, D. E. Meas. Instrum. Rev., 16: 37-9(Jan. 1969).

The purposes for which instruments are required by the health physicist are set out and the trend of design in general over the past decade is discussed with regard to nuclear instrumentation. (auth) (UK)

11809 PROVISION OF ANATOMICAL MARKERS FOR GAMMA CAMERA PICTURES. Barker, M. C. J.; Woods, R. H. K.; Smith, A. H.; Hayter, C. J. (General Infirmary, Leeds, Eng.). Int. J. Appl. Radiat. Isotop., 20: 140-1(Feb. 1969).

The clinical use of γ-emitting isotopes in distribution studies necessitates provision of some form of marker, so that areas of increased activity may be related to recognizable anatomical features. In scanners employing moving detectors it is relatively easy to transfer a mark on to the output when the detector is above any desired anatomical point, but such a procedure is not possible with the fixed detector gamma scintillation camera using a parallel multi-holed collimator. A simple and effective marker device is described, for use in conjunction with a gamma camera, together with methods of operation and illustrations of results obtained. (UK)

11810 A RE-ENTRANT WELL GAS FLOW PROPORTIONAL COUNTER FOR RADIOACTIVITY MEASUREMENTS OF SOLUTIONS CONTAINING ^{35}S AND OTHER RADIONUCLIDES. Lowenthal, G. C.; Page, V. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Int. J. Appl. Radiat. Isotop., 20: 130-3(Feb. 1969).

A multianode gas flow counter, fitted with a re-entrant well and operated in the proportional region, is described for the routine measurement of soft pure beta emitters and particularly ^{35}S in aqueous solution sealed in glass vials. Bremsstrahlung produced in the solution and the glass is counted in quasi 4 π geometry. The reproducibility is about ±6% for routine assays of ^{35}S activity, and most measurements require only a few minutes and no special precautions; with care and under slightly modified conditions it is considered that reproducibility can be improved to ±0.7%. The stability of the system was found to be within ±0.25% over a period exceeding 18 months. Errors due to somewhat non-uniform vial walls are discussed, and it is noted that large errors could occur with samples containing small amounts of radioactive impurities (a limit of 1 × 10^{-6} is necessary in many cases). The photon efficiency and stability of the instrument make it useful as a photon well counter, and for the half-life measurements of soft beta emitters (a half-life of 87.03 ± 0.21 d was obtained for ^{35}S). (UK)

11811 RESOLVING TIME OF A G.M. COUNTER AND ITS RELATION TO IONIC MOBILITY AND TEMPERATURE. Lindeman, H.; Mornel, E. (Technion-Israel Inst. of Tech., Haifa, Israel). Physica, 33: 691-4(1967).

With the use of scaling factor statistics as described earlier, the dependence of the resolving time, the dead time and recovery time of a G.M. counter on the temperature of the counter have been investigated. It was found that these quantities do not change when the temperature varies between −50°C and +50°C. Because of the relationship between dead time and recovery time and the mobility of the positive ions in the counter, this result may be seen as an indirect confirmation of Langevin's rigorous theory of ionic mobility. (auth)

11812 SPECTROMETRY OF ALPHA PARTICLES WITH SILICON SURFACE-BARRIER DETECTORS. Stepanov, E. K.; Tyutikov, N. V.; Podenko, N. P. Izmer. Tekh., No. 11, 57-8 (Nov. 1968). (In Russian).

The use of surface-barrier detectors with a larger area (up to 254 mm^2) and higher sensitivity at depths up to approximately 2 mm for alpha spectroscopy is discussed. (tr-auth)

11813 SYNTHESIS OF PHOTOGRAPHIC EMULSIONS FOR NUCLEAR STUDIES. Novikova, N. R. Usp. Nauch. Fotogr., 11: 135-60(1966). (In Russian).

After reviewing the history of the use of photographic emulsions in the Soviet Union and other countries, the methods of synthesis of such emulsions are described. These include (1) synthesis in excess bromide ions (ammonia method, ammonia-free double solvent method and ammonia-free three-solvent method), (2) synthesis in excess silver ions and (3) the diffusion method. A comprehensive list of the emulsions (and their applications) manufactured by various firms is given. A table indicating the characteristics of relativistic nuclear emulsions obtained by different researchers at different times is also presented. Improvements in the properties of nuclear emulsions should be concerned with decreasing the size of their single crystals and increasing the density of the grains in the tracks of relativistic particles. (ATD)

11814 POSSIBILITIES OF INCREASING SENSITIVITY OF RADIOIONIZATION DETECTORS FOR PERMANENT GASES BY APPLICATION OF GAS AMPLIFICATION. Lasa, Jan (Inst. of Nuclear Studies, Krakow). Chem. Anal. (Warsaw), 13: 1071-80 (1968). (In Polish).

Some results of research work on the possibility of increasing the sensitivity of ionization detectors for detection of permanent gases by applying gas amplification are presented. Some physical phenomena of gas amplification in two component mixtures in dependence upon the relation between their ionization potential are pointed out. Experimental characteristics of the cross-section and argon type detectors working at gas amplification are given. These results are presented for detectors working at different voltage and different gases used as the carrier gases. The level of detection which is connected with the fluctuation of ionization current while these detectors are working at elevated voltage has been also determined. (auth)

11815 DISTRIBUTION OF INDIVIDUAL GRAIN NOISE ON RELATIVISTIC TRACKS IN NUCLEAR EMULSIONS. Friedlaender, E. M.; Friedlaender, J. (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 13: 597-600(1968).

Preliminary results of a survey of the properties of the distribution of individual grain center distances from the particle path in nuclear emulsions indicate that this distribution is roughly Gaussian, with a standard deviation increasing with the initial grain radius of the emulsion. This dependence seems to prove that the growth of crystals during processing is on the average symmetrical about the grain center. (auth)

11816 DESIGN AND CALIBRATION OF A COUNTER FOR THE MEASUREMENT OF THE ATMOSPHERIC AND EARTH

LEAKAGE FLUX OF SECONDARY COSMIC-RAY NEUTRONS. Ballerini, R.; Boella, G.; Igiuni, A.; Inzani, P.; Scarsi, L. (Univ., Milan). Nuovo Cim., 59B: 49-64(Jan. 11, 1969).

A detailed description is given of a neutron counter employed in a combined balloon and rocket experiment, in which the integrated flux of neutrons in the thermal to 20 MeV energy range has been measured, as a function of atmospheric depth from 0.1 to 800 g/cm^2 residual pressure. The construction of the boron-plastic scintillation detector and its operation in phoswich with a particle scintillator, which suppresses charged-particle background, are discussed. The mechanical solutions of the environmental problems involved in the rocket launch are fully described. The complete calibration procedure of the instrument is presented; an evaluation is given of the contribution from locally produced neutrons to the counting rate. The results are presented from four balloon flights, carried out in March 1966 at 5.3 GV geomagnetic cut-off rigidity, as an intercalibration of the three units, used in the experiments. (auth)

11817 PROTECTION AND SECURITY AGAINST EXTERNAL IRRADIATION BY MEANS OF PERSONNEL DOSIMETRY. Rimondi, O. (CNEN, Bologna). Met. Ital., 60: 253-5(Oct. 1968). (In Italian).

The essential characteristics of a good personnel dosimeter are outlined. Film dosimeters for electromagnetic radiation and slow neutrons, thermoluminescence dosimeters, photoluminescence dosimeters, and fast neutron dosimeters are described. The film dosimeters have all the essential characteristics of personnel dosimeters. Often thermoluminescent and photoluminescent detectors are added to film dosimeters to give additional information. Nuclear emulsions for fast neutron dosimetry is, at the present, the most convenient. (J.S.R.)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 11752, 13159, and 13160.

11818 (ANU-P-413) LINE SHAPE ANALYSIS OF SPECTRA OBTAINED WITH Ge(Li) DETECTORS. Huang, F. C.; Osman, C. H.; Ophel, T. R. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 19p. Dep.

Line shape analysis techniques have been applied to gamma ray spectra obtained with a Ge(Li) detector. It was found that least squares fitting procedures enabled more accurate and rapid extraction of relative intensities than was possible from the areas of the full energy or double escape peaks. (auth)

11819 (PINSTECH/PHY-13) Ge(Li) DETECTOR USED IN A PAIR SPECTROMETER CONFIGURATION. Ahmed, Nighat Masud; Ishaq, Abul Faiz Mohammed; Najam, Mohammad Ramzan; Khan, Zafarullah; Khan, Hameed Ahmed (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). May 1968. 11p. Dep.

A three crystal pair-spectrometer with a Ge(Li) detector as the central crystal has been set up. It has been used to record the pair spectrum of ^{72}Ga. The results obtained and the relative efficiency calibration of the spectrometer are discussed. (auth)

11820 CALIBRATION OF 4π SCINTILLATION GAMMA SPECTROMETER WITH THE APPLICATION OF PEAK SUMMING. Vetrov, V. A. (Inst. of Applied Geophysics, Moscow). Prib. Tekh. Eksp., No. 5, 37-41(Sept.-Oct. 1968). (In Russian).

With the obtained relation of photocontribution and energy P(E) a calculated semiempirical curve of photoefficiencies for well-type crystals is described. The relation P(E) was used also for estimating the photoefficiency according to the peak summing method. Results obtained through each method are in good agreement. (tr-auth)

11821 OPTICAL METHOD OF CHECKING BENT-CRYSTAL X-RAY SPECTROMETERS. Dzeganovskii, V. P. (Inst. of Problems of Materials Management, Kiev). Prib. Tekh. Eksp., No. 5, 208-9(Sept.-Oct. 1968). (In Russian).

An optical method is proposed for checking bent-crystal x-ray spectrometers, in which the measurement of the bending radius is accomplished with a parallel beam of light and the objective method of determining the sharpness of representation. (tr-auth)

11822 DEVICE FOR CALIBRATION OF MAGNETIC SPECTROMETER ACCORDING TO STANDARD LINES. Skachkov, S. V.; Chumakova, R. V. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 5, 150-1(Sept.-Oct. 1968). (In Russian).

The field of a spectrometer determined by the zero method is compared with the field of an iron-free solenoid, for which synchronously they are turned 180°. Two counter-placed coils are described, from which one is the field of an electromagnet of a spectrometer and the other the solenoid. The calibration of the spectrometer consists in finding the relation P(I), where the P, momentum of electrons of an observed standard line, and I, the corresponding current of the solenoid upon compensation of signals from the coils. (tr-auth)

11823 MOESSBAUER SPECTROMETER FOR THE MEASUREMENT OF SMALL ISOMER SHIFTS. Kaindl, G.; Maier, M. R.; Schaller, H.; Wagner, F. (Technische Hochschule, Munich). Nucl. Instrum. Methods, 66: 277-82(Dec. 15, 1968).

A spectrometer designed for the measurement of small shifts of Moessbauer absorption lines is described. Three sources are simultaneously agitated by a single electromechanical velocity drive. The sources and three different absorbers can be cooled in a liquid-helium cryostat. By means of a specially designed electronic interface the three transmission spectra are stored in a single multichannel analyzer operated in time mode. A facility for simultaneously taking a calibration spectrum is provided. (auth)

11824 FLAT CRYSTAL SPECTROMETER FOR (n,γ) STUDIES. Nilsson, S.; Falkstroem, E.; Boreving, S. (Chalmers Univ. of Tech., Gothenburg, Sweden). Nucl. Instrum. Methods, 66: 229-45 (Dec. 15, 1968).

A diffraction spectrometer with two flat crystals is described. The spectrometer is fully automated and the results are punched on tape. The handling of data on a computer is described. Experimental results of (n,γ)-spectra, crystal structure studies and Doppler broadening of annihilation lines are briefly presented. (auth)

11825 FAST-NEUTRON SPECTROSCOPY WITH THICK ORGANIC SCINTILLATORS. Burrus, W. R.; Verbinski, V. V. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 67: 181-96(Jan. 15, 1969).

A neutron spectrometer which utilizes a 4.60- by 4.65-cm-dia. NE-213 liquid organic scintillator is described. Pulses due to gamma radiation are eliminated by the use of a modified Forté-type pulse-shape discriminator circuit. The FERDoR unfolding method and code are used to transform the measured pulse-height distribution into a neutron spectrum. This code produces an estimate of the neutron spectrum with a rigorous confidence interval. The effects of nonlinear scintillation characteristics, multiple scattering, and charged-particle reactions are all taken into account. The code is based on constrained minimization and utilizes the known nonnegativity of the neutron spectrum in obtaining the confidence intervals. The scintillator arrangement, the electronic circuit, and the FERDoR code are described. Typical results obtained by unfolding continuous and discrete line spectra are given. Satisfactory overall results were obtained with neutrons from 0.5 to over 16 MeV in a gamma-ray background of ≈5 mR/h. (auth)

11826 RESPONSE FUNCTION OF PROTON RECOIL TELESCOPES. Weise, K. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 67: 197-204(Jan. 15, 1969). (In German).

To determine the energy spectra of weak neutron sources by means of a proton-recoil telescope, the response function of the spectrometer is needed. A program is described to calculate the response function of proton recoil telescopes with foil radiators for any given measuring geometry, for any shape and arrangement of neutron source, radiator, and proton detector. The characteristic features of the response function depending on geometry and proton energy loss within the radiator are pointed out. (auth)

11827 SQUARE ROOT GRAPH PAPER FOR NUCLEAR SPECTRA. Verrall, R. I.; Bell, R. E. (McGill Univ., Montreal). Nucl. Instrum. Methods, 67: 353-4(Jan. 15, 1969).

The advantages of using a newly available square root graph-paper for nuclear spectra are illustrated by means of a sample spectrum plotted on linear, logarithmic, and square root scales. (auth)

11828 INVESTIGATIONS ON THE IMPROVEMENT OF THE EFFECTIVE RESOLUTION IN SCINTILLATION SPECTROMETERS. Roy, S. C.; Chatterjee, A.; Ghose, A. M. (Bose Inst., Calcutta). Nucl. Instrum. Methods, 67: 318-22(Jan. 15, 1969).

A method for resolving peaks in a scintillation spectrum which otherwise would overlap due to photomultiplier statistics is presented. The arrangement is quite flexible for varying light divisions between the two photomultipliers viewing one scintillating crystal. A differential discriminator accepts pulses from a fixed portion of the spectrum from one of the tubes whereas another differential discriminator scans the spectrum from the second tube, coincidence gated by the first. Experimental results presented show that the 1.33 MeV monoenergetic line from ^{60}Co source was separated and resolved; the effective resolution was made better by increasing the light input to the second photomultiplier. (auth)

11829 THE USE OF AN ON-LINE COMPUTER TO DIVIDE SIGNALS FROM A POSITION-SENSITIVE DETECTOR. Debenham, P. H.; Dehnhard, D.; Goodwin, R. W. (Univ. of Minnesota, Minneapolis). Nucl. Instrum. Methods, 67: 288-92(Jan. 15, 1969).

The x · E-signals and the E-signals from a position-sensitive detector in the focal plane of a magnetic spectrometer were divided with the aid of a CDC 3100 computer, to cancel the appreciable energy spread in both signals when the incident particles were passing through the detector. A momentum resolution $p/\Delta p = 4200$ was obtained. (auth)

11830 AUTOMATION OF THE ANALYSIS OF GAMMA RAY SPECTRA OF RADIONUCLIDE MIXTURES, WITH SPECIAL REFERENCE TO COMPUTER SPECTRUM SHIFTING AND DEAD TIME CORRECTION. Gavron, A. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Instrum. Methods, 67: 245-50 (Jan. 15, 1969).

A method is described which permits the transfer of a multichannel analyzer output spectrum of a mixture of radionuclides to a computer for analysis of the components, without any additional manual data processing or recording. Details of a computer method of automatic spectrum shifting assuming a polynomial energy-channel dependence are given. Also described in detail is a computer method of compensation for the reduction in the number of counts due to the dead time of the multichannel analyzer. (auth)

11831 USE OF SCINTILLATORS CONTAINING DEUTERIUM TO ANALYSE THE FAST NEUTRON SPECTRUM. Benetskii, B. A.; Burymov, E. M.; Frank, I. M. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 920-3(Nov. 1968). (In Russian).

A method for the fast neutron spectroscopy using a scintillation detector containing deuterium is described. Cross sections measured by means of this method are presented and the comparison with results of other authors is performed. (auth)

11832 A MAGNETIC, CHARGED-PARTICLE SPECTROMETER. Maikov, V. N.; Murashova, V. A.; Syreishchikova, T. I.; Tel'nov, Yu. Ya.; Yakimenko, M. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 38-65(1968). (In Russian).

A precision of better than 1% was obtained in the study of the Compton effect of high-energy (~650 MeV) electrons on the synchrotron of the Physical Institute. This high precision required an efficient recording of the low-energy (<2 MeV) γ quanta and the spectrometric evaluation of high-energy (~600 MeV) Compton electrons with an angular resolution of $<2 \times 10^{-2}$ with respect to the primary γ quanta beam. The spectrometer developed made it possible to record simultaneously electrons in the range of ±16% at the maximum mean energy of 600 MeV. The minimum value of the stabilizing magnetic field amounted to ~90 MeV. In addition to the basic counter for recoil electrons resulting from the scattering of γ quanta on electrons, the system included also a 2-channel γ spectrometer with a resolution of ~2% for investigating the stability of the upper energy level of the accelerator. A 10^3 electrons/sec monochromatic electron beam was also obtained for calibration measurements. (TTT)

11833 EXPERIMENTAL METHOD FOR DETERMINING THE EFFICIENCY FUNCTION OF A DEVICE INCLUDING A MAGNETIC SPECTROMETER. Grushin, V. F.; Leikin, E. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 66-79(1968). (In Russian).

A measuring system which allows the recording of charged particles formed by the interaction of a charged particle beam with a nuclei of the target, was investigated. The pulses generated by the secondary particles were examined by means of a magnetic spectrometer placed between the target and the detector. The efficiency function of the system, indicated by the correlation between the solid angle and the charged particle pulses, depends on the input orifice of the magnetic spectrometer, the geometry of the target-spectrometer-detector system and the focusing and analyzing characteristics of the magnet, together with the dimensions of the target. This efficiency function was experimentally determined on the basis of an earlier method described by the authors which involved the measurement of the differential cross section of the generation of π^+ mesons on hydrogen by the γ quanta of the bremsstrahlung of the synchrotron. The method made possible to determine the solid angle with a precision of ±2.7%. The difference between experimental and theoretical values is attributed to the deviation of the real magnetic field from the ideal field used in the calculations. (TTT)

11834 ABSOLUTE MAGNETIC SPECTROGRAPH FOR MEASURING NUCLEAR ENERGIES. Alba, F.; del Castillo, H.; Dacal, A.; Roos, R.; Mazari, M. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 17: 215-33(1968). (In Spanish).

A 180° absolute magnetic spectrograph has been designed and built for measuring nuclear reaction Q values. Its principal features are: 100 cm mean radius of curvature; energy ratio $E_{max}/E_{min} = 1.2$; 19 mm gap; maximum field 12,000 gauss. The field may be measured every 10° and the distance from the target to the plate index may be measured, all without opening the vacuum. Errors in the measurement of ^{210}Po alpha particle energies are estimates to be about 400 eV. (auth)

11835 ANALYSIS FOR GAMMA RADIATION SPECTRUM BY COMPUTER. Inoue, Tamon (Tokyo Shibaura Electric Co., Ltd.). Bunseki Kiki, 6: 616-19(Sept. 1968). (In Japanese).

A method for automatic analysis by computer of complex gamma spectra detected with a high resolution Ge(Li) detector was described and applied to a few examples. The data with large statistical fluctuations were smoothed by determining a filter function, in the numerical calculation of which the fast Fourier transform technique was used. The background components in detected spectra were eliminated by the use of the distribution of minimum values obtained from the smoothed data. In classifying peaks of spectra, the position and area of each component were determined by assuming that the peak identified to be multiplet was the overlap of the normal distributions with the standard peak width in each energy determined by the background peak width. Using the fact that the resolution ability was determined through the intensity distribution in the region of comparatively high energy frequencies, the resolution was practically increased by laying emphasis on the high frequency region. This method was applied to the analysis of the thermal neutron capture gamma radiation spectrum and to the fast neutron activation analysis. (NSA of Japan)

11836 PRECISION MEASUREMENTS OF CONTINUOUS BETA SPECTRA. Zemann, H.; Semrad, D. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Acta Phys. Austr., 27: 31-9(1968). (In German).

Instrumental effects that occur in measuring continuous beta spectra by means of a Siegbahn–Slätis intermediate image spectrometer, are discussed. Corrections or upper limits for these effects are given. The results are applied to the measurement of the ^{114}In and ^{32}P spectra, and it is found (see table) that both agree with the statistical shape. (auth)

11837 APPLICATION OF SPECTROMETER WITH GERMANIUM DETECTOR FOR ACTIVATION ANALYSIS. Borisov, G. I.; Demidov, A. M.; Zakharov, E. A. At. Energ. (USSR), 26: 14-19(Jan. 1969). (In Russian).

A spectrometer with a germanium detector was used for analysis of impurities in reactor materials (in the alloy AD-1, graphite and beryllium oxide), for determination of the contents of silver in the aluminum-silver alloy, and the contents of tantalum in the tantalum concentrates, and also in developing methods to determine the content of oxygen in GaAs. The measurements were carried out by germanium detectors of 2, 5, and 8 cm³ volume. (auth)

11838 EFFECTS OF SCATTERED RADIATION ON THE CALIBRATION OF GAMMA RAY DETECTORS. Klumpar, J. Czech. J. Phys., 18: 1335-44(1968). (In German).

Using published values for the albedo, theoretical formulas were derived, which enable the evaluation of errors for the calibration of gamma ray detectors, caused by the photonic components of radiation scattered by different adjoining masses. Their validity and the admissibility of the applied simplifications were verified by experiments. The quantitative evaluation of the contribution of the soft (mainly electronic) component of scattered radiation was carried out experimentally. The effect of electrons originating in the mass of the surrounding air is great. This is the main reason the use of collimated beams is preferred. As a further advantage they allow a greater distance between the source and the detector, so that the geometrical error given by the dimensions of the detector may be essentially reduced. (auth)

11839 DOUBLE-CRYSTAL SPECTROMETER WITH RELATIVELY HIGH VERTICAL DIVERGENCE AND INSTRUMENTAL DISTORTION OF X-RAY SPECTRA. Drahokoupil, J.; Fingerland, A. (Inst. of Solid State Physics, Prague). Czech. J. Phys., 18: 1190-1203(1968).

The problem of vertical divergence on the double-crystal spectrometer is treated, both theoretically and experimentally. It is shown that, even in the case of finite vertical divergence, one may get the resulting profile of the measured spectral line as a convolution of the true spectral line and the instrumental smearing function. The general method of calculating this smearing function is given. Further, the influence of the vertical divergence is separated, and some general features are derived. In the experimental part, a double-crystal spectrometer for the fluorescent method of excitation and the precise adjustment of the instrument is described in detail. The theoretical formulas concerning instrumental smearing, the dependence of the peak intensity and the shift of the maximum on the vertical divergence are verified experimentally. (auth)

11840 IMPROVEMENT OF THE RESOLVING POWER OF SCINTILLATION ALPHA SPECTROMETERS. Gladkova, I. V.; Glukhovskoi, B. M.; Govorova, R. A.; Dobryak, V. G.; Zakharin, Ya. A.; Labushkin, V. G.; Prosyak, V. A.; Ruzer, L. S. Izmer. Tekh., No. 11, 55-7(Nov. 1968). (In Russian).

An experiment is described which shows the relation between the resolution of the scintillation spectrometer and the integral sensitivity of the photomultiplier cathode and the thickness of the crystal. (tr-auth)

11841 ACCURATE MEASUREMENTS OF ENERGIES OF CERTAIN GAMMA TRANSITIONS. Balalaev, V. A.; Medvedev, A. I.; Ter-Nersesyants, V. E.; Uchevatkin, N. F.; Shestopalova, S. A. Izmer. Tekh., No. 11, 59-60(Nov. 1968). (In Russian).

A background-free, double-focusing, $\pi\sqrt{2}$ beta spectrometer was calibrated at energies of 500 to 2600 keV. Special attention was devoted to values, which were the weighted average of all measurements appearing in the press up to June 1966. They were K510.7 ^{208}Tl, K661.6 ^{137}Cs, K1173.2 ^{60}Co, K1332.5 ^{60}Co, and K2614.4 ^{208}Tl. On the basis of the energy calibration and careful measurements the energies (in keV) of the following transitions were determined: 1449.94 and 1479.69 in ^{170}Yb, 900.84 and 1093.34 in ^{172}Yb, 1121.15 and 1221.22 in ^{182}W. These determined energies can also be used for calibration purposes. (tr-auth)

11842 USE OF CsI(Na) CRYSTALS IN NUCLEAR γ RESONANCE SPECTROMETERS. Zemskov, B. G.; Govorova, R. A.; Labushkin, V. G.; Panova, A. N.; Shiran, N. V. Izmer. Tekh., No. 10, 42-3(Oct. 1968). (In Russian).

Various types scintillators and photomultipliers were studied in order to select the most effective scintillator for nuclear gamma-resonance studies under various conditions. Luminescence yields and spectrometric properties of NaI(Tl), CsI(Na), and CsI(Tl) were compared using a γ-source ^{119}Sn (E_γ = 23.8 keV) in a spectrometer consisting of scintillation counter and multichannel analyzers. The constructed curves show that CsI(Na) luminescence yield is similar to the yield of NaI(Tl) and can be used effectively in nuclear γ-resonance spectrometers and in the Mossbauer effect studies. (R.V.J.)

11843 ENERGY DEPENDENCE OF WALL IONIZATION CHAMBERS IN THE MEASUREMENT OF X RADIATION WITH AN ENERGY OF 10 TO 200 keV. Balon, Z. P.; Savel'ev, V. D. (Central Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 14: No. 1, 43-9(Jan. 1969). (In Russian).

During the manufacture of ionization dosimetric apparatus for radiations of 20 to 200 keV (E_{eff} – 10 to 100 keV) there occur difficulties in the choice of proper material of wall chambers which ensure a constant effectiveness of the apparatus for radiations in the given energy range. Based upon calculations with the use of Spiers' theory for calculation of the distribution of absorbed dose in bone cavities filled with soft tissue, the ratios between the wall and gas components of the current in chambers of diverse form and size were determined. The calculation of a two-component air-equivalent mixture established that a mixture of 89.5% Cu + 10.5% Al ensures the air-equivalence for radiations ranging from 20 to 100 keV. The results of calculations were verified experimentally with chambers of practical dosimeters. (auth)

11844 HIGH-RESOLUTION GAMMA-SPECTROMETRY WITH LITHIUM-DRIFTED GERMANIUM DETECTORS. PART I. Bueker, H. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 10: 687-94(Dec. 1968). (In English and German).

The structure and operation of a lithium-drifted germanium detector are discussed. The generation of an output pulse is described. A comparison is made of the resolution capacity of Ge(Li) and NaI detectors. A comparison is also made between Ge(Li) and NaI detectors for gamma spectroscopy. The design of typical detector chamber for large volume Ge detectors is examined. (B.G.D.)

High Energy Physics Instrumentation

Refer also to abstract 13031.

11845 (BNL–13060) THE ROLE OF HUMAN GUIDANCE IN A FAST MEASUREMENT SYSTEM. Connolly, P. L.; Delaney, W. C.; Hough, P. V. C.; Howie, J. M.; Kinsey, R. R.; Morris, T. W.; Nardi, J. A.; Werntz, T. L. (Brookhaven National Lab., Upton, N. Y.). Oct. 25, 1968. 9p. (CONF-681025–10). Dep. CFSTI.

From International Conference on Advanced Data Processing for Bubble and Spark Chambers, Argonne, Ill.

The design of advanced computer based film analysis systems for bubble chambers and its relation to the role of human guidance in film scanning are discussed. (B.G.D.)

11846 (BNL–13130) LARGE DIGITIZED SPARK CHAMBER SPECTROMETER AND ON-LINE COMPUTER SYSTEMS. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). Dec. 11, 1968. 21p. (CONF-681025–12). Dep. CFSTI.

From International Conference on Advanced Data Processing for Bubble and Spark Chambers, Argonne, Ill.

A double V (vertex) magnetic spectrometer system consisting of two multiparticle magnetic spectrometer arms, utilizing spark chamber hodoscopes with automatic digitation of spark location, via magnetostrictive readout digitized by scaler readings, is described. It is designed for the automatic detection and measurement of the momenta of charged decay particles from double vertex events. The raw data is handled by a local data handler which stores the data in a local computer memory and between AGS pulses (every 2.5 sec) sends a preselected sample to the PDP-6 computer system of the Brookhaven On-Line Facility. This on-line facility is also described. (auth)

11847 (COO–1195-154) THE UNIVERSITY OF ILLINOIS DOLLY SYSTEM. Brown, Richard M.; Downing, Robert W. (Illinois Univ., Urbana). [nd]. 10p. (CONF-681025–7). Dep. CFSTI.

From International Conference on Advanced Data Processing for Bubble and Spark Chambers, Argonne, Ill.

A modified version of the POLLY system for bubble chamber film scanning is proposed. called DOLLY. Notable differences from the POLLY design are multiple CRT film drive, larger scanning aperture, digital distortion corrections and slice scanning. and slice segment alignment and curvature. (W.H.K.)

11848 (JINR–P13-4012) MEASUREMENTS OF CARTESIAN COORDINATES USING A SEMIAUTOMATIC DEVICE FOR SCANNING AND MEASURING SPARK CHAMBER PICTURES. Vzorov, I. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 9p. (In Russian). Dep.

A method is described for the determination of cartesian coordinates on a semiautomatic device which is designed for measuring polar coordinates of particle tracks in spark chamber photographs. (B.G.D.)

11849 (SLAC-PUB–529) SLAC SPIRAL READER PROJECT. Anderson, M.; Budenaers, D.; Caponera, J.; Cochran, R.; Good, R.; Hoard, C.; Hu, M.; Jensen, Mark (Stanford Linear Accelerator Center, Calif.); Brafman, H. (Weizmann Inst. of Science, Rehovoth (Israel)). Nov. 1968. 9p. (CONF-681025–9). Dep. CFSTI.

From International Conference on Advanced Data Processing for Bubble and Spark Chambers, Argonne, Ill.

The design characteristics of the SLAC spiral reader which is used to process bubble chamber film are discussed. These include the projection system, film transport system, electronic and interface logic, and on-line control program and calibration program. (B.G.D.)

11850 (UCRL–18546) AUTOMATIC SCAN. Franz, Joan (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 28, 1 968. Contract W-7405-eng-48. 8p. (CONF-681025–11). Dep. CFSTI.

From International Conference on Advanced Data Processing for Bubble and Spark Chambers, Argonne, Ill.

The automatic scan program (516) is a C-level 7094 program which reads a data abstract tape and selects events, assigns event types and edits data onto magnetic tapes in the standard HAZE format. The data abstract tape, which is a result of A and B-level DAPR program operation, contains track coordinates for each view and a list of tracks associated with each spacial vertex. In selecting events, straight-forward programming techniques are applied to impose physics selection criteria upon the data. The program outputs a DAPR scan report which lists the selected events by frame and vertex location. If a manual pre-scan tape is also input, the DAPR scan report will list pre-scan comparisons. The method by which the program selects events from the data abstract tape is described. In order to discuss the method, the nature of the selection criteria is first considered. (auth)

11851 SELECTION SYSTEM FOR MEASURED TRACKS IN THE SCANNING ZONE. Buyukyan, S. P.; Nanasyan, A. S. (Inst. of Physics, Erevan). Prib. Tekh. Eksp., No. 5, 58-60(Sept.-Oct. 1968). (In Russian).

The selection system for measuring projectors for analysis of bubble chamber photographs, which operates on the principle of manual following of the measured track in the scanning zone, is described. The logic of construction of the system, which realizes the prediction of a point on the track on the basis of two previous points, is examined. The system used in the measuring projector at the Erevan Inst. of Physics is described. (tr-auth)

11852 ANGULAR MEASUREMENT OF FISSION FRAGMENTS IN IONIZATION CHAMBERS. Basova, B. G.; Ivanov, O. I.; Kushnir, Yu. A.; Shimanskii, A. M. Prib. Tekh. Eksp., No. 5, 53-8 (Sept.-Oct. 1968). (In Russian).

The method used for angular measurements of fission fragment tracks in scintillation ionization chambers, permitting the use of the chamber for multiparameter measurements of energy and angular distribution of fission fragments, is described. The angle between the direction of the electric field of the chamber and the direction of scattering of fission fragments is determined for the pulse time lag on the collecting electrode of the chamber. The angular resolution is characterized by dispersion $(\cos\theta - \overline{\cos\theta})^2$ equal to 0.03 at $\theta = 90°$ and 0.06 at $\theta = 0°$. (tr-auth)

11853 POWER SUPPLY FOR MULTIGAP SPARK CHAMBERS AND CHAMBERS WITH LARGER GAPS. Zhankov, I. K.; Kuznetsov, V. M.; Stukov, O. I. (Tomsk Polytechnic Inst., USSR). Prib. Tekh. Eksp., No. 5, 50-2(Sept.-Oct. 1968). (In Russian).

A method for supplying multigap spark chambers and chambers with large gaps from one generator is described. The method is shown to have 100% efficiency for both chambers. (tr-auth)

11854 BROAD-RANGE MAGNETIC SPECTROMETER WITH HIGH RESOLUTION AND HIGH LUMINOSITY. Afanasev, N. G.; Goldshtein, V. A.; Dementii, V. S.; Yaroshevskii, L. D. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 5, 41-2(Sept.-Oct. 1968). (In Russian).

Experimental results are presented on the performance of a double-focusing magnetic spectrometer with homogeneous field. The spectrometer has a resolution of 0.3% and luminosity of 8.2×10^{-3} ster. It is to be used for the study of angular distributions and the energy spectra of particles with energies up to 1.0 GeV. (tr-auth)

11855 EFFECTS OF MODIFICATION OF THE COMPONENTS OF AIR ON THE OPERATION OF SPARK COUNTERS. Kawata, S.; Maeda, K. (Konan Univ., Japan). Nucl. Instrum. Methods, 66: 343-7(Dec. 15, 1968).

Effects of addition of water vapor, CO_2 and A to nearly ordinary composition of air and variation of the proportion of O_2/N_2 on the operation of spark counters were investigated. (auth)

11856 FAST SONIC SPARK CHAMBER. Brinckmann, P. (Univ., Bonn). Nucl. Instrum. Methods, 67: 352(Jan. 15, 1969).

A spark chamber is described where the sound wave exited by the spark in the metal electrodes is detected and can be used for calculation of the spark position. This spark chamber offers the same speed as wire chambers, can be given any desired form and its operation is not influenced by magnetic fields. (auth)

11857 ON A POSSIBILITY OF FILMLESS OBTAINING OF INFORMATION USING A DISCHARGE CLOUD CHAMBER. Manjavidze, Z. Sh.; Javrishvili, A. K.; Roinishvili, V. N. (Inst. of Physics, Tbilisi, USSR). Nucl. Instrum. Methods, 67: 348 (Jan. 15, 1969).

A possibility to obtain information without films using a new detector of charged particles, a discharge-cloud chamber, is discussed. Television equipment with video tape recording is used. (auth)

11858 MEASUREMENTS OF THE RELATIVISTIC INCREASE OF THE SPECIFIC PRIMARY IONIZATION IN A STREAMER CHAMBER. Davidenko, V. A.; Dolgoshein, B. A.; Semenov, V. K.; Somov, S. V. (Moscow Physical Engineering Inst.). Nucl. Instrum. Methods, 67: 325-30(Jan. 15, 1969).

The possibility of measuring the primary ionization in a streamer chamber is shown. The relativistic increase of the specific primary ionization in the chamber filled with helium up to 0.6 atm is measured with a 2% accuracy. (auth)

11859 WIDE-GAP STREAMER CHAMBER. Rice-Evans, P.; Mishra, S. R. (Bedford Coll., London). Nucl. Instrum. Methods, 67: 337-40(Jan. 15, 1969).

A 20-cm gap streamer chamber is described together with details of the high voltage circuitry. An analysis of measurements on the tracks in the various modes of operation shows that an angular resolution of 1.5 mrad is attainable. (auth)

11860 IONIZATION MEASUREMENTS OF BUBBLE CHAMBER TRACKS WITH THE TELEVISION MEASURING PROJECTOR. Yekutieli, G.; Yaffe, R.; Toaff, S. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Instrum. Methods, 67: 305-8(Jan. 15, 1969).

Results on ionization measurements of bubble chamber tracks, with the Television Measuring Projector are reported. The ionization is measured up to 4 × minimum, with relative error of less than 20%. Protons and pions can be identified and separated up to 1.5 GeV/c. The ionization measurements are used, with the help of the ionization χ^2 test, to choose the correct hypothesis of bubble chamber events, with 93% success. (auth)

11861 MAGNETOSTRICTIVE SPARK CHAMBERS IN A MAGNETIC FIELD. Golutvin, I. A.; Zanevskii, Yu. V.; Kiryushin, Yu. T.; Peshekhonov, V. D.; Ryabtsov, V. D.; Sitnik, I. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 67: 257-60(Jan. 15, 1969).

The effect of magnetic fields up to 15 kOe on the characteristics of spark chambers with magnetostrictive readout is discussed. The measurements were made in a magnetic field of 12.5 kOe. The efficiency and accuracy of particle detection are measured. (auth)

11862 WILSON CHAMBER FOR INVESTIGATING PHOTOMESON PROCESSES. Andreev, V. P.; Ivanov, Yu. S.; Makarov, R. N.; Zhukov, V. T.; Okhotin, V. E.; Usova, I. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 204-14(1968). (In Russian).

Although the excessively long dead time prevents the use of Wilson and other types of chambers on accelerators, their application is highly desirable for many research fields, such as the study of many-particle reactions. In order to use Wilson chambers for studying photomeson processes in synchrotrons, the intensity of the γ-ray beam that can pass through the chamber for each impulse without impairing the quality of the tracks must be increased as much as possible. A chamber was used on the synchrotron of the Physical Institute of the Academy of Sciences at a mean γ-ray intensity of $\sim 1.5 \times 10^5$ photons per impulse. The supercompression technique used allowed to reduce the operational cycle of the chamber to ~10 sec, involving an adiabatic increase of the pressure up to 110 to 120% of the initial one. The chamber was operated at a gas temperature 1 to 2°C below the wall temperature to avoid sweating. About 2500 stereophotograms were taken with hydrogen, in order to determine the operational conditions; a $\gamma + p \rightarrow p + \pi^0$ reaction was examined, choosing the events on the basis of recoil protons. At present, ~75,000 sterophotograms taken with deterium, are being examined for studying the $\gamma + d \rightarrow d + \pi^0$ reaction at the range of the second resonance. (TTT)

11863 COMPARATIVE MONITOR FOR THE WILSON CHAMBER. Andreev, V. P.; Kovaleva, T. I.; Usova, I. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 215-19(1968). (In Russian).

A comparative monitor for measuring the energy flux in a photon beam passing through a Wilson chamber must be able to operate continuously for at least 10 days at the relative error of ±2%, responding only to γ ray pulses which cause the expansion of the chamber. Such a device was constructed and tested; its photographic system started only if the intensity of the γ radiation exceeded a certain previously determined value. The γ radiation energy was measured by means of a plane-parallel ionization chamber made of Plexiglas and aluminum alloy; it was characterized by a rapid collection of ions. The linearity of the amplitude-time transformation and of the amplification was verified by means of a generator; the system was calibrated using the quantometer described by R. Wilson. The scatter of the data was found not to exceed ±2%. (TTT)

11864 AN INSTRUMENT FOR RECORDING NEUTRAL PARTICLES ON THE BASIS OF THE DECAY γ QUANTA. Aleksandrov, Yu. A.; Kutsenko, A. V.; Maikov, V. N.; Pavlovskaya, V. V. Tr. Fiz. Inst., Akad. Nauk SSSR, 40: 3.37(1968). (In Russian).

An instrument was developed at the High-Energy Electron Laboratory of the Physical Institute for recording correlated $\gamma\gamma$ coincidences; it is able to measure two γ quanta in the 100- to 650-MeV range, and therefore may be used for studying processes in which γ quanta are formed, such as the interaction of elementary particles yielding short-lived neutral mesons which decay into two γ quanta (π^0 meson, η meson). The system includes total-absorption Cherenkov spectrometers with an energy resolution between ±19 and ±9%; the energy of each of the γ quanta may be determined within a resolution time of $\sim 5 \times 10^{-9}$ sec. The instrument was used for investigating the photogeneration of η mesons on carbon nuclei in the bremsstrahlung beam of the synchrotron, it was found to operate reliably for extended periods of time. It may be connected with an M-20 type computer, facilitating the handling of data. (TTT)

Radiation Dosimeters

Refer also to abstracts 11585, 11752, and 12254.

11865 (DPST-68-610) SEMIAUTOMATIC TLD READER. Splichal, W. F. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 1968. Contract AT(07-2)-1. 13p. Dep. CFSTI.

A semiautomatic thermoluminescent dosimeter reader was developed to measure simultaneously the light emitted from two TLD's. The reader has adjustable nitrogen purge, preheat, heat, and signal storage which can be set up to cycle automatically with a minimum of operator manipulation. Provision is made to plot a glow curve during heating and to provide a digital readout at the end of the reading cycle. Individual heating, high voltage, and sensitivity controls enable the instrument to measure light emitted from either powder or crystal TLD's exposed to a wide range of radiation levels. (auth)

11866 (UCRL-71328) PERSONNEL DOSIMETRY ASSOCIATED WITH THE HANDLING OF LARGE NUMBERS OF 3-kg ^{239}Pu BILLETS. Myers, David S.; Prevo, Charles T. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 10, 1969. 15p. (CONF-690103-3). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

The current operations of the Lawrence Radiation Laboratory, Livermore, critical array study group involve the handling of up to 128 plutonium billets. Each of the billets contains approximately 3 kg of ^{239}Pu (including small quantities of other plutonium isotopes) clad in aluminum and stainless steel. When the billets are handled individually, they present a hand dose problem; however, when they are in sizable arrays, the whole-body dose becomes the controlling factor. Although ^{240}Pu is present only in small quantities, its relatively short spontaneous fission half-life produces a significant neutron flux (approximately 5×10^5 neutrons/sec per billet). The neutron film (Kodak type NTA) proved quite unsatisfactory for measuring whole-body neutron doses in these studies; thus the technique used to establish the whole-body neutron dose rate was to measure the neutron-to-gamma dose rate ratio for the array environment radiation using a variety of gamma and neutron detectors. Since the neutron-to-gamma dose rate is dependent upon the size, spacing, and moderation of the array, a new ratio is determined for each array. A neutron-to-gamma dose rate ratio was also established for billet surface radiation using computer techniques. The neutron dose is then established by applying the measured neutron-to-gamma ratio to the whole-body gamma dose as measured by the film badge, and to the gamma hand dose as measured by thermoluminescent dosimeters. (auth)

11867 LET DEPENDENCE OF THERMALLY STIMULATED EXOELECTRON EMISSION. Becker, K.; Chantanakom, N. (Oak Ridge National Lab.,Tenn.). Nucl. Instrum. Methods, 66: 353-4(Dec. 15, 1968).

If the emission rate of low-energy electrons from the surface of irradiated ionic crystals is plotted as a function of temperature, a characteristic curve with one or several peaks which are related to the surface trap distribution, is obtained. It has been observed that the peak ratio in some materials such as $CaSO_4$, $SrSO_4$, and $BaSO_4$ is different after exposure to alpha and to gamma radiation. The fading kinetics also depend on LET. This effect is of interest for several dosimetric applications of thermally stimulated exoelectron emission. (auth)

11868 A NEW RECTAL DOSIMETRY CATHETER FOR USE IN RADIATION THERAPY OF CARCINOMA OF THE UTERINE CERVIX. Sheldon, J. J.; Vuksanovic, M.; Wold, G. J.; Fonts, E. A. (Univ. of Miami, Fla.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 120-5(Jan. 1969).

Measurements are compared between a flexible rectal dosimetry catheter consisting of lithium fluoride thermoluminescent dosimeters in tandem and the rigid scintillation detector probes that is in general clinical use. (B.G.D.)

11869 MODULATION TRANSFER FUNCTIONS OF THE IONIZATION CHAMBER. Uchida, Suguru (Osaka Univ.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 185-95(Jan. 1969).

The blur in the measurement system is analyzed by bringing into the dosimetric system the concept of Modulation Transfer Function (MTF) which has recently been introduced into the radiographic system with fruitful results in the analysis of images. In this paper, the dosimetry, in air and in depth, of 190 kVp x rays and ^{60}Co γ rays is treated, respectively. First, the values of calculations and experiments of MTF of an ionization chamber are obtained. Then the MTFs of the dose distribution of the collimated field measured by the ionization chamber are obtained. After some treatments are given to these MTFs in the spatial frequency domain, the real dose distribution of the field is evaluated by inverse Fourier transforms. The results of experiments obtained are discussed in the light of the assumptions for calculations. Thus by the method of Fourier analysis, it has become possible to know the real dose distribution by correcting the errors of blurring caused by the chamber size, although this has long been regarded as difficult. Therefore, the application of Fourier analysis is tried not only to obtain the expression of MTF of the ionization chamber, but to go a step farther, and to also measure the real dose distribution. (auth)

11870 IMPROVEMENTS IN OR RELATING TO ARRANGEMENTS FOR HEATING THE RADIATION-SENSITIVE MATERIAL OF THERMOLUMINESCENT DOSIMETERS. (to Manufacture Belge de Lamps et de Material Electronique). British Patent 1,139,698. Jan. 8, 1969. Priority date Sept. 21, 1965, Belgium.

An apparatus was designed for electrically heating a thermoluminescent dosimeter which includes a current regulator that maintains a constant current for dose readout. (B.G.D.)

11871 MEASUREMENT OF RADIATION DOSE DISTRIBUTION IN A POND HABITAT BY LITHIUM FLUORIDE DOSIMETRY. Guthrie, J. E.; Scott, A. G. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. J. Zool., 47: 17-20(Jan. 1969).

Thermoluminescent dosimetry has been used to measure the radiation dose accumulated by Chironomidae larvae inhabiting a 19-m diameter pond contaminated with cesium-137. Small plastic tubes filled with lithium fluoride powder were arranged in parallel rows along the pond bottom. The accumulated gamma dose was greatest at the pond margin. (auth)

11872 ALBEDO-SOME ASPECTS OF AN OPTICAL CONCEPT INTRODUCED IN RADIATION PHYSICS. Carlsson, C. A. (Univ. of Lund, Sweden). Health Phys., 16: 232-4(Feb. 1969).

The term "albedo" means "whiteness," a concept used principally in astronomy to express the capacity of planets, etc. to reflect visible sunlight. The term is also used in meteorology to express reflection of solar energy from different parts of the Earth's crust. In radiation physics the term is used for describing the reflection of neutrons and photons in reactors and screening barriers, but in this field it has been used with different definitions. Since the concept may be useful in dosimetry, it is discussed in the light of its proper definition. Various shapes of reflecting medium are considered. (UK)

11873 REFLECTION ON THE USE OF ACTIVATION DOSIMETERS IN REACTOR OPERATION. Tschirf, E. (Oesterreichische Hochschule, Vienna). Acta Phys. Austr., 27: 195-204(1968). (In German).

Two dosimeters were prepared: one from phosphorus and gold for routine measurements in reactor operation, which can detect doses of 300 mrem and one from sulfur and gold for the establishment of catastrophic doses of over 12 rem with which an evaluation is still possible for a longer time after the irradiation. The two dosimeters are described, and the sources of error in the activation method are discussed. The measurement error was calculated for the dosimeter under practical conditions. The tabulated results show that the phosphorus-gold dosimeter under the most unfavorable conditions has an error under 14.5% after one hour. In the use of the sulfur-gold dosimeter for a measurement period of 48 hours a good dose determination is possible in relation to other methods. (J.S.R.)

11874 FILM DOSIMETRY OF X RAYS BY MEANS OF RADIOACTIVE SOURCES IN A SHIELDED, TRANSPORTABLE, CALIBRATION FACILITY. Paic, Valerija (Univ. of Zagreb). pp 97-106 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The evaluation of the effective energy of x rays to which a film was exposed is presented, Ilford PM3 films are used. The film badge has one portion without a filter and six portions with filters of various thicknesses of copper (0.1 to 0.97 mm), on both sides. The optical density under the portion without a filter D(O) and under Cu filters D(t), can be used in three different manners for the evaluation of effective energies of x rays, namely: by measurements of the half value photographic density layer in the case of effective energies ranging between 25 and 83 keV, by the ratio D(O)/D(t) as a function of the thickness of copper filters in the case of effective energies, ranging between 25 and 135 keV, and by the ratio D(O)/D (0.1 mm Cu) as a function of effective energies between 25 and 55 keV, or by the ratio D(O)/D (0.97 mm Cu) as a function of effective energies between 51 and 156 keV. The use of a ^{226}Ra, ^{137}Cs or ^{90}Sr$-^{90}$Y/Al source, in a shielded, transportable calibration facility, for the establishment of log D(O) = f (log X), in the interval 25 keV $\leq E_{eff} \leq$ 156 keV of x rays is also discussed. In one set of experiments log D(O) = f (log X) calibration curves were obtained by x rays of E_{eff} between 25 and 156 keV. In another set, log D(O) = f (log X) calibration curves were obtained by means of radioactive sources in a shielded, transportable calibration facility. Because of the great difference in photographic sensitivity in the two energy intervals (x rays: 25 keV ≤ E_{eff} ≤ 156 keV; gamma rays: 662 keV to 1.25 MeV mean), it is necessary to give the PM3 films, in the calibration facility with radioactive sources, 6- to 10-fold higher exposures than to the films exposed to x rays. Using the two sets of measurements, calibration factors were determined. (auth)

11875 RANGE AND DEPTH DOSE DISTRIBUTION OF LOW-ENERGY CHARGED PARTICLES IN DOSIMETER GLASSES. Becker, K. (Naval Radiological Defense Lab., San Francisco). pp 135-40 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A new method for the direct determination of particle ranges and depth dose distributions in silver-activated phosphate glasses is based on the successive removal of extremely thin surface layers from the exposed glass by chemical etching (peeling) and measurement of the residual radiophotoluminescence between successive etchings. Glass composition, etching chemicals, and etching speed can be varied within wide limits. The experimental technique, using Yokota-type dosimeter glasses and 28% NaOH at 60°C (etching speed 0.12 μ/min) is briefly described. As an example of the practical application of the method, measurements using several types of radiation sources (aqueous solutions of ^{3}H, ^{63}Ni and ^{35}S, solutions and thin and thick solid sources of ^{239}Pu, ^{237}Np and ^{235}U, monoenergetic protons, deuterons and He^{+} ions in a wide energy range) have been made. Accuracy, possibilities and limitations of the method are briefly discussed. Possible sources of error are: discoloration of the glass because of very high surface doses; uncertainties in the determination of the etching speed; etching speed along charged particle tracks higher than the bulk etch rate for ions of very high LET. (auth)

11876 A NEUTRON DOSEMETER WITH SPHERICAL MODERATOR CONTAINING ABSORBERS AND A BF_3 COUNTER. Rotondi, E.; Geiger, K. W. (National Research Council, Ottawa). pp 141-5 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The Bonner moderating sphere, 25 to 30 cm in diameter, is widely used because of its isotropic and dose equivalent response for neutrons over an energy range from near thermal to about 10 MeV. However, two properties of the instrument limit its convenience: (1) the LiI scintillation counter in its center tends to make it difficult to use the instrument in high γ-fluxes, also response changes of the scintillation counter make frequent recalibrations necessary. (2) The moderating sphere is rather large and heavy for a portable instrument. The use of a BF_3 thermal neutron counter of 5 cm sensitive length and 2.5 cm diameter eliminated all difficulties mentioned under (1). Insertion of cadmium discs at appropriate locations in the polyethylene sphere near the counter ends made the response isotropic for all neutron energies. To improve on (2), neutron absorption studies were made in a slab geometry containing cadmium and polyethylene sheets, so as to obtain the best Rem dose response for neutrons from an Am-Be source (E_{av} = 4.4 MeV) and from a Sb-Be source (E_{av} = 40 keV). On this basis, a compact neutron dosimeter 20 cm in diameter containing an inner cadmium shell of 10 cm diameter was constructed and tested. (auth)

11877 A PULSE ANALYSIS SYSTEM AND COMPUTER PROGRAM FOR THE ROSSI LET COUNTER. Dvorak, Robert F. (Argonne National Lab., Ill.). pp 295-305 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Acceptance of the Rossi LET counter for routine health physics use depends upon the degree to which data collection and analysis can be simplified. An electronic system for recording counter events and a computer program prepared for data analysis that contribute toward this end are discussed. In developing this system, it was found that spectral stability is significantly affected by voltage and gas purity through the mechanism of varying ion collection time. Circuitry has been developed which delays sampling of the pulse height until full charge collection has been achieved. Operation as a sealed chamber has thereby been achieved over useful periods. Since the spectra realized are typically exponential in shape, extremely long data collection times are required to achieve statistical significance for the large pulses. To ameliorate this problem, an analog pulse height computer is used to compress the high energy deposition end of the spectrum according to a selectable power function before pulse height analysis is performed. The data analysis program has been made as flexible as possible to allow further studies in interpretive procedure. The raw data for both radiation field and background (where applicable) are smoothed before determining net counts. The technique used has a minimum of bias as to the spectrum shape. The smoothed spectrum is then analyzed and a probable LET spectrum determined. Since the energy loss spectrum due to mono-LET particles traversing the chamber depends on questionable assumptions, options are included for triangular, exponential, and square stripping functions. From the LET spectrum, the dose and dose equivalent are calculated, and the LET spectrum is smoothed and plotted. Examples are given of the results produced by the system for typical radiation sources. (auth)

11878 PHOTOGRAPHIC DOSIMETRY: BETA-GAMMA CALIBRATION. Olivares, M. P.; Perez Modrego, S. (Hopital de San Juan de Dios, Madrid). pp 107-14 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Photographic radiation dosimetry may be defined as the measurement of the dose of a particular electromagnetic or corpuscular radiation by means of establishing a one-to-one correspondence between dose and photographic effect. It is therefore of importance to delineate the terms dose and photographic effect clearly and to understand the difficulties inherent in the measurement of these quantities. The International Commission on Radiation Units recommended that dose be expressed in terms of the quantity of energy absorbed per unit mass of irradiated material at the place of interest. Measurements of the photographic effect are made in terms of diffuse transmission density, representing the logarithm to base 10 of the opacity of a processed photographic film sample. The difficulty in relating dose to photographic density lies in the fact that while the roentgen is a measure of radiation absorbed in air, the photographic action of x- or γ-radiation is essentially the result of ionization in the silver-halide crystals of the photographic emulsion and in the materials surrounding it. The fundamentals of photographic dosimetry are set forth, making next a study of the characteristic curve in different types of films exposed to the radiations emitted by radium and cobalt sources of different exposure intensity. Then a study is made on the variation of the characteristic curve with the conditions of processing, the film emulsion, the irradiation rhythm, the energy spectrum of the radioactive source employed, and the different types of films, indicating the most convenient conditions to carry out a good calibration. Similarly, the possibilities of the films studied in individual radiological controls are discussed. (auth)

11879 THERMOLUMINESCENCE RESPONSE OF LiF TO X AND GAMMA RAYS: A STUDY OF RATE AND ENERGY DEPENDENCE OVER A WIDE RANGE OF EXPOSURES. Ehrlich, Margarete (National Bureau of Standards, Washington, D. C.). pp 429-34 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The total thermoluminescence light emission response of LiF (TLD grade) was studied as a function of exposure and exposure rate, and as a function of photon energy. ^{60}Co gamma rays and a broad spectrum of low-energy bremsstrahlung were employed. No rate dependence of the response was detected over the entire range of exposures and exposure rates employed (from about 10^2 R to 2×10^7 R, and from about 10^2 R/h to 7×10^6 R/h, respectively). This represents further evidence that centers other than f centers are involved in the thermoluminescence of LiF (TLD grade). A comparison of the curves of response versus exposure for the two photon spectra confirms Naylor's findings that the superlinearity region is steeper for ^{60}Co gamma radiation than for low-energy x rays, and reveals that the effect is indeed dependent on photon energy rather than on exposure rate. These findings are compatible with an explanation of superlinearity as being due to the formation of additional traps by the radiation proper. For exposures above those causing superlinearity, the difference in curve shape again disappears. Also, there is no dependence on energy of the location and height of the response maximum, which suggests that the inhibiting mechanism is independent of photon energy. (auth)

11880 OPERATIONAL TRIALS OF LUMINESCENCE DOSIMETERS. Burton, L. K.; Foster, C. J.; Townsend, S. (Central Electricity Generating Board, Berkeley, Eng.). pp 435-47 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Since the AERE/RPS film holder containing Kodak RM film is the legally accepted method of exposure monitoring in the U.K., comparisons have been made between luminescence dosimeters and film badges over a wide range of conditions. Good correlation was obtained when lithium fluoride samples were attached to film badges, but not when the two were issued together, with instructions that they should be worn close to one another. This indicates that more attention should be given to studying the spatial distribution of dose over the body. A comparison was made between fingertip mounted lithium fluoride samples and film badges worn on the wrist. For operations involving the handling of fission product contaminated material the ratio between the doses measured by the two systems varied between 1 and 20 : 1. Lithium fluoride in teflon has been used for some measurements. Although this is physically more convenient to use than the powder, some samples produced a low temperature glow peak with a short decay time. This rendered rapid measurements inaccurate. Dosimeters, readout devices, and ancillary equipment are discussed from the operational aspect and disadvantages of present equipment are given, together with suggestions for developments required to produce operationally more acceptable equipment. (auth)

11881 MEMORY EFFECTS WITH M.B.L.E. CaF_2 THERMOLUMINESCENT DOSIMETERS. Van Espen, Eric (Manufacture Belge de Lampes et de Materiel Electronique, Brussels). pp 449-50 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The thermoluminescent (TL) dosimetry methods become more and more popular for all applications where personal protection against radiation is needed. For instance, in nuclear installations, civil populations in the case of nuclear accident and military personnel in case of a nuclear conflict. The existing TL systems are very convenient for these applications, as well for low doses as for high doses. However, the principle of TL does not offer theoretically more than one measure of the same dose because of the erasing phenomena caused by the reading process. This erasing characteristic excludes a new reading of the dose in case of an official control or further check. To fulfill these multireading requirements, three practical methods giving the total accumulated dose and the reading of the dose received between two measurements with the same dosimeter are described. These principles are: thermal inertia, multipeak reading, and light transfer effect in some CaF_2 fluorines. These three methods are discussed with their respective performances and application field and the conclusion is that they lead from now to a TL dosimeter which combines both properties of photoluminescent and thermoluminescent systems. (auth)

11882 COMPARISON OF TLD AND FILM FOR PERSONNEL DOSIMETRY. Cameron, John R.; Suntharalingam, N. (Univ. of Wisconsin, Madison). pp 451-5 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The film badge is today the most widely used personnel monitoring device for want of a more reliable and accurate system. Recent evaluations of the performance of the available commercial film badge services report a wide variation in both the accuracy and consistency of the reported exposures. The best accuracy that one can obtain for x and gamma radiation appears to be −50 to +200%. The feasibility of using the thermoluminescence of single crystals of LiF (TLD-100) to measure exposure levels of x and gamma radiation encountered in the personnel dosimetry range is reported. The use of single crystals greatly reduces the contribution of the non-radiation induced thermoluminescence. The variation in response of individual crystals was taken into account by calibration of the crystal in place at the time of readout. LiF single crystals in lucite capsules were attached to film badge holders and given known test exposures from x- and gamma-ray sources and mixtures of these radiations. The performance of the TLD system is compared with the measured values reported by the film badge suppliers. No correction was made for the slight energy dependence of LiF at the low keV exposures. The overall accuracy of the TLD system is about ±30% for x- and gamma-ray energies above 25 keV effective. (auth)

11883 PILOT COMPARISON OF TWO THERMOLUMINESCENT DOSIMETRY SYSTEMS WITH FILM BADGES IN ROUTINE PERSONNEL MONITORING. Johnson, T. L.; Attix, F. H. (Naval Research Lab., Washington, D. C.). pp 457-72 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

An intercomparison was made of the performance of two thermoluminescent dosimetry (TLD) systems and conventional film badges in a routine γ-ray personnel monitoring operation. Quartz fiber pocket dosimeters were worn in some cases also but were read out more frequently than the monthly interval used for the other systems. One of the TLD systems consisted of the U. S. Navy experimental prototype Computer–Indicator CP-748(XN-1)/PD and Detectors DT-284 (XN-1)/PD (respectively the reader and dosimeters). The other was a commercial model of foreign manufacture which will be referred to here as the M system. Both of these types of dosimeters employed calcium fluoride TLD material sealed in a glass envelope with an internal ohmic heater. The M dosimeters were found to agree with the DT-284's within 10% + 6 mR almost without exception and within 10% + 3 mR in three cases out of four. The quartz-fiber dosimeters agreed with the DT-284's within 10% + 6 mR in three fourths of the cases. 20 mR was regarded as the minimum exposure detectable with the film; in the 31 cases where the film exceeded this minimum, it also exceeded the DT-284 reading by 10% + 25 mR in 18 cases. and by 10% + 50 mR in 8 cases. Both types of TLD's were found to contain radioactive contamination which gave rise to background readings in excess of ambient background by ≈21–24 mR/mo. (auth)

11884 SOME IMPROVEMENTS ON SPHERICAL CAPSULE TYPE GLASS DOSIMETER. Yokota, Ryosuke (Tokyo Shibaura Electric Co., Lt.); Muto, Yuhei; Naoi, Jiro; Nishijima, Shunji. J. Nucl. Sci. Technol. (Tokyo), 6: 46-8(Jan. 1969).

Modifications to a spherical capsule badge case, developed by Priesch (Atompraxis, Direct Information 17: 14(1964)) in order to house recently developed glass photoluminescent dosimeters, are described. (B.G.D.)

11885 USE OF GLUCOSE DOSIMETER AS STANDARD INDICATOR OF GAMMA-RADIATION HIGH DOSES. Generalova, V. V.; Kishinevskaya, M. B.; Vainshtok, B. A. At. Energ. (USSR), 26: 31-5(Jan. 1969). (In Russian).

A chemical dosimeter based on the effect of optical activity decrease of 20% aqueous glucose solution during irradiation, is recommended for the determination of the absorbed gamma-ray energy within the range of $10^6 - 4.10^8$ rad. The absorbed dose $D = 1/K \ln \varphi_0/\varphi$, where φ_0 and φ is the angle of rotatory polarization before and after irradiation: for 20% aqueous glucose solution $K = 3.9 \times 10^{-3}$ Mrad^{-1}; the error of dose determination is 3%. Principal advantages of the dosimeter as compared with the known chemical dosimeters are the following: the independence on dose rate, on the presence of air oxygen, on the temperature of irradiation and measuring; the rapidity and sufficient accuracy of determination of radiation effect and of calculation of absorbed dose; the stability of unirradiated samples in regard to light and temperature, the absence of posteffect; good reproducibility of the results. (auth)

11886 DOSIMETER WITH A MINIATURE TRANSISTORIZED Si(Li) DETECTOR. Meshcheryakov, A. B.; Petushkov, A. A.; Glezin, F. I. (Inst. of Industrial Sanitation and Occupational Disease, Moscow). Med. Radiol., 14: No. 1, 53-8(Jan. 1969). (In Russian).

A dosimeter of roentgen and gamma-radiation is described with a miniature transistorized Si(Li) cylindric detector. Subject to determination were the dosimetric characteristics of the device in the fields of roentgen radiation. A description of technical details and the sensitivity of the device are presented. (auth)

Radiometric Instruments

Refer also to abstract 11726.

11887 MEASUREMENTS OF THE THICKNESS COATINGS BY THE RADIOMETRIC ANALYSER MNG 201. Sulc, Jaroslav (Technical Coll. of Mechanical and Textile Engineering, Liberec, Czech.). Jad. Energ., 15: 24-7(Jan. 1969). (In Czech).

Some experimental results dealing with the influence of the scattering angle of backscattered beta particles on the course of calibration curves by the use of the radiometric analyser MNG 201 for measurements of thickness coatings are described. (auth)

11888 THICKNESS (MASS PER UNIT AREA) GAUGE VA-T-70B-SPECIAL LAYOUT FOR DIAMETER GAUGING. Traeber, K. (VEB Vakutronik, Dresden). Isotopenpraxis, 4: 437(Nov. 1968). (In German).

The characteristics of the VA-T-70B diameter gage are tabulated. The radioactive element is ^{85}K and an ionization chamber is the detection unit. (J.S.R.)

11889 MEASURING OF MOISTURE CONTENT BY MEANS OF RADIOACTIVE ISOTOPES. Piene, Hroar (Institutt for Atomenergi, Kjeller, Norway). Tek. Ukebl., 115: 991-3(Nov. 7, 1968). (In Norwegian).

Among the methods for measuring moisture contents in solids is the use of a fast neutron-emitting source and a slow-sensitive detector for counting the neutrons effectively slowed down by the hydrogen content of the water. An instrument based on this principle has recently been developed at the Norwegian Institutt for Atomenergi. The instrument also measures the density of the solid and combines the two measurements in a simple manner to give the weight percentage of water in the solid as the final result. The instrument is mainly based on digital circuits, combining simplicity, reliability, stability and favorable economy. The first prototype is intended for measurement in coke, while other applications are being discussed. (auth) (Norway)

11890 IMPROVEMENT IN THE METHOD OF RADIOACTIVE VISCOSIMETRY. Fuia, H.; Cretu, Tr. (Institutul Politehnic Gheorghe Gheorghiu-Dej, Bucharest). Bul. Inst. Politeh. Bucuresti, 30: No. 3-4, 97-102(May-Aug. 1968). (In Rumanian).

By means of the suggested methods, it is possible to calculate directly the falling speed of a radioactive ball in the liquid under consideration from the successive experimental determination of the follow-up speed at certain time intervals. Using a glass ball in which a radioactive source of maximum ^{60}Co has been trapped, the falling speed in silicone oil was determined with an accuracy of about 5%. (auth)

11891 BETA SOURCES IN ELECTRONIC MEASURING SYSTEMS. Dooley, H. H. Instrum. Contr. Syst., 41: 77-8(Aug. 1968).

The parameter and applications of β-excited luminous radiation sources are discussed. Their major advantages such as continuous activated lines in excess of 50,000 hr, no external power requirements, no heat production, largely independent of such external condition as temperature, rf, and vibration, highly reliable, and mass production are described. (TSS)

11892 PARACHUTE-BORNE BETA-RAY DENSITOMETER. Ballard, Harold N. (White Sands Missile Range, New Mex.); Sellers, Bach; Izquierdo, Miguel pp 86-93 of Proceedings of the Third National Conference on Aerospace Meteorology, May 6-9, 1968, New Orleans, La. Boston, Mass., American Meteorological Society, 1968.

See CONF-680534.

The design, fabrication, operating principles, and performance of a parachute-borne beta-ray densitometer, consisting of an annular-shaped radioactive source and an annular array of Geiger counter tubes with associated electronics, are discussed. The densitometer is for determining atmospheric density in the 60-30 km region of the atmosphere. (B.G.D.)

11893 CALIBRATION OF NEUTRON RADIOMETRIC DEVICES. Vasil'ev, R. D.; Dorofeev, G. A.; Petrov, V. I. Izmer. Tekh., No. 10, 41-2(Oct. 1968). (In Russian).

Calibration of intermediate and fast neutron radiometric devices was achieved using $\gamma-$ and $\alpha-$beryllium sources and thermal neutron radiometric devices by means of $\alpha-$beryllium source placed in a paraffin ball. Calculations of various neutron radiometric devices showed that with the order of error of ±5% for determining the yield of isotopic neutron sources the basic calibration error did not exceed ±15%. (R.V.J.)

11894 DETERMINATION OF THE BETA-ACTIVITY OF PATTERN MATERIALS WITH CONSIDERABLE THICKNESS OF STRATUM. Viragh, Elemer. Magy. Radiol., 20: 311-16(Oct. 1968). (In Hungarian).

Two methods are described, by means of which, with knowledge of the stratum thickness of the pattern material, correction of the results of the measurements is possible. In the first method, the ^{40}K activity found in the natural potassium compounds is used for the verification of the beta radiation measuring instruments. By means of the absorption method, the correction of the self-absorption is obtained on the basis of two measurements (direct measurement and measurement performed with an absorbent of known thickness). (auth)

11895 LATEST STATE OF DEVELOPMENT OF CONTROL INSTRUMENTS FOR THE CONTINUOUS MONITORING OF DUST EMISSIONS. Duewel, Ludwig (Technischer Ueberwachungs-Verein Rheinland e. V., Cologne). Staub, 28: No. 3, 42-53(Mar. 1968).

A survey of instruments which have been developed for the continuous sampling and measurement of dust concentrations in the air in factories is presented. Methods include gravimetric, differential pressure, photoelectric scanning, electrical contact, small ion deposition, and beta-ray attenuation. Also, light scattering and light absorption techniques are discussed. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 11444, 11512, 11640, 12206, 13263, and 13538.

11896 (BNWL-SA-2085) TRENDS IN LOW-LEVEL MULTIPLEXING. Mahan, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 13, 1968. Contract AT(45-1)-1830. 45p. (CONF-680937-1). Dep. CFSTI.

From IEEE Meeting, Richland, Wash.

The state-of-the-art in low-level multiplexers as reported in currently available literature reveals that electromechanical commutators offer superior performance in most electrical performance categories. It should be stressed, however, that the degree of superiority is extremely small with regard to most parameters. Cost is the one parameter where electromechanical MUX's have a significant advantage. The primary defects in electromechanical MUX's are in sampling speed and long term reliability. Block switching offers an alternative to the speed limitation, but only if quasi-random access addressing can be tolerated. The closest competitor to electromechanical MUX's are the new FET MUX's which offer an order of magnitude higher speed and greater reliability, but currently cost about twice as much as comparable electromechanical systems. Electrical performance differences are modest with the one exception of common mode voltage protection. However, protection schemes have been devised and will be tested in the laboratory to determine feasibility. In addition, bench tests will be conducted on a production FET MUX to determine whether the overall performance agrees with the figures cited in the literature. (auth)

11897 (CERN-68-41) GATING OF PHOTOMULTIPLIERS. Bartl, W. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 9, 1968. 13p. Dep.

After intense illumination of the photocathode of a photomultiplier, a discharge of the photocathode, called paralysis, sometimes occurs which reduces the gain of the photomultiplier. Two grid blanking systems are described to correct this perturbation. In one system a pulse is applied to the focusing electrode of the photomultiplier, and in the other system a pulse is applied to a grid outside the photocathode. Results are given. (W.H.K.)

11898 (IFVE-SVM-68-44-K) MODIFICATIONS OF "MINSK-2" AND "MINSK-22" NECESSARY FOR THE WORK OF THE MONITOR SYSTEM. Akimov, Yu. A.; Belotsvetov, A. E.; Belyaevskii, L. V.; Mikhailov, Yu. V.; Sokolov, S. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 21p. (In Russian). Dep.

The usual stop instruction, due to an illegal instruction (pseudocode), overflowing, and a magnetic tape fault, is replaced by an interruption. Electronic clock and time interruption are added. The duration of the execution of an instruction as well as a call to an unswitched peripheral unit are controlled. The number of words input from punched tape is controlled. This additional circuitry gives the possibility to organize at a Minsk-22 computer a programmed diagnostics of overflowings and continuous chaining of jobs in the automat state by means of a monitor system of programs. (auth)

11899 (MLM-1545(tr)(del)) ION CAGE. Paul, Wolfgang; Osberghaus, Otto; Fischer, Erhardt. Translated by D. W. Eppink (Mound Lab., Miamisburg, Ohio), from Forschungsber. Wirt. Verkehrsmin. Nordrhein-Westfalen, No. 415, 1-38(1958). 39p. Dep. CFSTI.

This report supersedes MLM-1545(tr).

Experiments with a high frequency electric field are described in which the absolute value of the field strength increases outward in all directions quadratically with increasing distance from the center point of the field. Such a field has electrically charged particles (ions) of given mass and charge; three dimensional oscillations exist around the center point of the field with appropriate choice of frequency and field strength of the electric field. The ions can no longer leave the field as long as they do not deviate from their path due to collision. The equation of motion of the particles is a linear, homogeneous differential equation of the type of Mathieu's differential equation with periodic variable coefficients. The existence of the stable oscillating ions was detected with a resonance-absorption circuit, just as with the Purcell nuclear resonance method. The arrangement can be used as a mass spectrometer. (auth)

11900 (RPI-328-142, pp 152-63) INSTRUMENTATION DEVELOPMENT. (Rensselaer Polytechnic Inst., Troy, N. Y.).

A fast-slow coincidence system was developed for the 1.25-m-diameter liquid scintillator, and the system was used to make high-resolution neutron capture measurements. Two 5-in.-diameter multiplate spark chambers were constructed, and the fission detection efficiency of the spark chambers was determined. (D.C.W.)

11901 (SC-CR-68-3598) DEVELOPMENT OF FLIP CHIP TECHNIQUES FOR CONSTRUCTING MONOLITHIC MULTI-CHIP ARRAYS. Final Report. Stork, F. W. (Hughes Aircraft Co., Newport Beach, Calif.). Nov. 1967. Contract 57-1766. 74p. Dep. CFSTI.

A five-bit binary counter module was developed utilizing standard purchased monolithic circuit chips mounted to a bumped substrate using flip-chip techniques. Two-level metallization process was developed for both the monolithic circuits and the thin film substrate. RF-sputtered glass is used as the dielectric insulator. The integrated circuit chips are ultrasonically bonded to the raised contact bumps on the alumina substrate and then reflow soldered for optimum bonding strength. A specially designed lead frame is also reflowed to the substrate to form external lead connection and package seal simultaneously, resulting in a completely wireless fabrication concept. (auth)

11902 (TID-24925) COUNTING NOTE: PULSE RESPONSE OF COAXIAL CABLES. Kirsten, F.; Wallace, R. (California Univ., Berkeley. Lawrence Radiation Lab.). July 29, 1966. 13p. Dep. CFSTI.

For most cables useful in counting work, attenuation below approximately 1000 MHz is due mainly to skin-effect losses and varies as the square root of frequency. For such cables the step-function response has a rise time that varies as the square of the attenuation at a given frequency. Curves are given to aid in the selection of cables for transmitting nanosecond pulses. (auth)

11903 X-RAY APPARATUS WITH THREE-ELECTRODE TUBE. Tsukerman, V. G.; Dotsenko, V. I.; Finogenov, V. M.; Merkel, G. T. (Inst. of Automation and Electrometry, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 5, 205-8(Sept.-Oct. 1968). (In Russian).

An industrial x-ray apparatus developed at Acad. Sci. USSR is described. The apparatus consists of a three-electrode x ray tube and a vacuum measuring chamber. The design of the tube provides the transfers of anode and cathode and also a change in the opening of the controlling electrode. The use of the tube in a pulsed mode, the regions of stabilization of anode currents and the intensities of radiation, automatic radiation monitoring, and also modulation permit better understanding of the problems involved in x-ray technology. (tr-auth)

11904 TIME-TO-AMPLITUDE CONVERTER IN MICROSECOND RANGE FOR THE INVESTIGATION OF ASYMMETRY OF μ-e DECAY. Meleshko, E. A. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 5, 77-81(Sept.-Oct. 1968). (In Russian).

The design characteristics and performance of a time-to-amplitude converter to be used for the study of asymmetry in μ-e decay in weak magnetic fields are discussed. Besides the time-to-amplitude converter other devices were used such as linear gates, coincidence circuits, and delay lines for blocking double μ-mesons. The range studied was 1.5 to 4.0 microseconds, the differential linearity was ±2%, and the time resolution was 2 nanoseconds. (tr-auth)

11905 CONCERNING THE RELATION BETWEEN SIGNALS IN DIFFERENT RECORDING SYSTEMS. Volkov, N. G.; Lyapidevskii, V. K. (Moscow Engineering-Physics Inst.). Prib. Tekh. Eksp., No. 5, 86-8(Sept.-Oct. 1968). (In Russian).

Methods were examined for determination of signals which emerge due to the yield from one multichannel analyzer used for recording of radiations using known signals due to the yield of another system, when both systems are recording from the same radiation field. A system with two-yields was used for determination of exposure, absorbed dose, the average energy of radiation, and quality factor. (tr-auth)

11906 SPECTROMETRIC MEASUREMENTS WITH MINSK-2 COMPUTER. Vladimirov, V. A.; Duda, F.; Zabiyakin, G. I.; Lysenko, Z. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 5, 89-93(Sept.-Oct. 1968). (In Russian).

The possible variations in the construction of a system for multichannel analysis with the use of a Minsk-2 computer are discussed. The parameters of a computer-based recording apparatus can be a basis for the comparison of multichannel analyzers with a fixed program of work and small computers. The introduction of specialized regions of work for computers does not change its capabilities as a multipurpose computer. (tr-auth)

11907 A METHOD OF DIGITAL EVALUATION OF CORRECTIONS IN COINCIDENCE MEASUREMENTS. Seda, Josef (Dept. of the Nuclear Physics and Engineering Faculty, Prague). Jad. Energ., 15: 11-15(Jan. 1969). (In Czech).

A method is described for automatic corrections relating to dead time, random coincidences and background in $4\pi\beta$-γ coincidence measurements. The counting rates measured are evaluated by connecting onto the output of the equipment a pulse counter indicating the resulting corrected value. The main advantage of the method is that the dead time corrections in the case of a single pulse sequence are inserted by a single equipment common to all measuring channels. The need of three pulse counters and of numerical calculations of the corrected value is omitted in this method. (auth)

11908 PSEUDO-RANDOM DIGITAL TRANSFORMATION. Bonacic, V.; Soucek, B.; Culjat, K. (Inst. Ruder Boskovic, Zagreb). Nucl. Instrum. Methods, 66: 213-23(Dec. 15, 1968).

To increase the resolution of pulse height analyzers from thousands to millions of channels, it was necessary to introduce a completely new technique. This was achieved through digital pseudo-random transformation. Passing through a transformation box, each event (descriptor) produces a pseudo-random address into which it is stored. A few different transformations are compared and analysed. Transformations are designed on the basis of multiplication of polynomial, Hamming's Sindrom calculations and division of polynomials. The experiments show that the division of polynomials is most suitable for transformation of nuclear data. It spreads the cluster of descriptors in the physical field equally over the whole range of the memory. The structure of the polynomial is determined by a circuit for counting in a Galois field code. Properties of the transformation with respect to the n-dimensional space are discussed. (auth)

11909 INDUCTANCE EFFECTS ON CAPACITIVE LOADING OF A TUNNEL DIODE. Morris, J. E. (Univ. of Saskatchewan, Saskatoon); Tan, Z. C.; Earnshaw, J. B. Nucl. Instrum. Methods, 66: 246-52)dec. 15, 1968).

The switching analysis of a tunnel diode with a parallel capacitive load is extended to include the cases of stray tunnel diode and lead inductance. Computed and experimental waveforms are presented and these are discussed using simple analytical models. Some applications of the capacitively loaded tunnel diode are briefly described. (auth)

11910 CAPACITIVE-SENSITIVITY OF CHARGE-SENSITIVE PREAMPLIFIERS. Poenaru, D. N. (Inst. of Atomic Physics, Bucharest). Nucl. Instrum. Methods, 66: 325-7(Dec. 15, 1968).

Calculation formulas are derived for the charge-sensitive preamplifier output pulse-height vs semiconductor detector capacitance characteristic, $v_0(C_D)$. The influence on the shape of this characteristic by the preamplifier load resistance, R_L, is emphasized. It is shown that the sensitivity $\Delta v_0/\Delta C_D$ is determined by the input dynamical capacity C_i and R_L/R_∞ ratio, where R_∞ is the preamplifier open-loop output resistance. High sensitivity is needed when the measurement of semiconductor detector capacity is performed, in contrast to the usual spectrometric working condition. An increase of this sensitivity can be easily obtained by means of a small value load resistor placed in parallel with the preamplifier charge-sensitive section output. The calculations are experimentally checked up on a cascode with bootstrapped plate load vacuum-tube preamplifier. (auth)

11911 SATURABLE TRANSFORMER FOR THE MEASUREMENT AND REGULATION OF THE MAGNETIC FIELD OF AN IRON-FREE DOUBLE-FOCUSING $\pi\sqrt{2}\beta$ SPECTROMETER. Dionisio, J. S. (CNRS, Orsay, France); Guterman, C. Nucl. Instrum. Methods, 67: 213-21(Jan. 15, 1969). (In French).

A new device, derived from the flux gate method, is described.

This instrument can be applied to the measurement of constant or slowly varying magnetic fields in the range between 10^{-4} Oe and 3×10^2 Oe. Its accuracy is, at least, 2.5×10^{-5} between 7 and 300 Oe. The magnetic field of a double focusing $\pi\sqrt{2}$ magnetic β spectrometer of the Siegbahn–Svartholm type is stabilized with an accuracy of the same order of magnitude using the error signal between the voltage proportional to the magnetic field induction (measured by such magnetometer on the central circle of the spectrometer) and the reference voltage (given by a highly stabilized power supply). (auth)

11912 SEVEN-BIT ANALOG-TO-DIGITAL CONVERTER FOR NANOSECOND PULSES. Porat, D.; Hense, K. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 67: 229-39(Jan. 15, 1969).

The time integral of nanosecond pulses is digitized with a linearity, resolution and stability <1%. The sensitivity of the circuit is 1.2 pC/count. The circuit can also be utilized for measurement of short time intervals. In this mode its sensitivity, for standard logic pulses (−0.7 V), is ≈ 80 ps/count. (auth)

11913 DEVICE DETECTING BLOCKING PATTERNS IN SOLIDS. Anastassiades, A.; Andritsopoulos, G.; Filippakis, S.; Gangas, N. H. (Democritus Nuclear Research Center, Athens). Nucl. Instrum. Methods, 67: 240-4(Jan. 15, 1969).

In the present work we describe an automatic device for detecting charged particle patterns due to blocking effects in solids. The operation of the device is based on a television-like scanning of the sensitive area of a solid state detector, and its subsequent mapping on a multichannel analyzer screen. Results obtained with a single crystal (Ge) and a polycrystalline material (Ta) are presented. (auth)

11914 GAS RECOIL NEUTRON POLARIMETER. Manduchi, C.; Moschini, G.; Tornielli, G.; Zannoni, G. (Univ., Padua). Nucl. Instrum. Methods, 67: 267-71(Jan. 15, 1969).

The performance of an experimental device employed to measure the neutron polarization is discussed. The polarimeter is designed so that data may be taken simultaneously in a wide angular range. The method of performing the measurements is illustrated by measuring the spin polarization of neutrons from the D(d,n)^{3}He reaction elastically scattered on ^{4}He. A critical examination is made of the properties of the polarimeter. (auth)

11915 ON METHODS OF SAMPLING WATER FOR DETERMINATION OF ^{90}Sr IN RADIOECOLOGICAL DETERMINATIONS. Timoshchuk, V. I. (Inst. of Biology of the Southern Seas, Sevastapol, USSR). Okeanologiya, 8: 546-9(1968). (In Russian).

A set of devices for total water sampling from shallow-water regions and for water sampling from the hyponeustonic layer near the water (0 to 5 cm) is described. An integral bathometer for the shallow-water total water sampling, which handles 25-liter samples, is illustrated. The design of a settling vat for precipitation of radionuclides is given; it has several advantages over similar units previously described. Sampling of water samples from near the surface is described, with use made of a special device for sampling of the hyponeustonic layer of the sea. These devices are combined with an electric stirrer in the radionuclide determination techniques used by the Institute. (BBB)

11916 MULTIMODULATED CYCLOTRON MASS SPECTROMETER WITH ALTERNATING PULSES. Ioanoviciu, D.; Mercea, V. (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 13: 683-95 (1968).

The possibility of using n modulators in an instrument based on the cyclotron resonance principle with trapezoidal pulses is investigated. Expressions of dispersion and of resolution are presented. The instrument with n modulators is compared with the instrument with one modulator and with n turns on the intermediate orbit. (auth)

11917 PROPERTIES OF PHOTOMULTIPLIERS WITH CAESIUM TELLURIDE PHOTOCATHODES. Charman, W. N. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., E (London), 2: 157-61(Feb. 1969).

The properties of a sample (seven tubes) of EMI type 9616 developmental photomultipliers having solar-blind, cesium telluride photocathodes are described. Results are given for the spectral sensitivity, the tube electron gain and pulse height distribution, and the cathode dark emission as a function of temperature. The results are compared with previous studies of this type of cathode and it is suggested that both the small unwanted response in the visible part of the spectrum (about 10^{-4} electrons per photon) and the slight dark emission (about 10 electrons cm^{-2} s^{-1} at 20°C) observed in the present cathodes are associated with an excess of cesium over the stoichiometric amount required for the compound cesium telluride. (auth)

11918 DEVELOPMENT OF FLUIDIC SYSTEMS FOR NUCLEAR PLANT CONTROL. Galli de Paratesi, S.; Ghiurghi, L.; Musik, H. (EURATOM, Ispra, Italy). pp B6-77-88 of Proceedings of the Third Cranfield Fluidics Conference, Turin, Italy, May 8–10, 1968. Vol. I. Cranfield, Eng., British Hydromechanics Research Association, 1968.

See CONF-680537–1.

The high inherent reliability and stability of fluidics when exposed to high temperature and nuclear radiation makes it particularly suitable for nuclear control and instrumentation systems. The applications of fluidics described include the self-acting control of a pile pneumatic oscillator, the automation of installations for irradiation experiments, the level control of fuel storage pools, and the control of a liquid fast shut-down system. (UK)

11919 NEW HIGH-GAIN DYNODE FOR PHOTOMULTIPLIERS. Simon, R. E.; Sommer, A. H.; Tietjen, J. J.; Williams, B. F. (RCA, Princeton, N. J.). Appl. Phys. Lett., 13: 355-6 (Nov. 15, 1968).

A new photomultiplier is described in which the recently reported GaP(Cs) material is used for the first dynode to obtain high secondary emission gain. Gain factors of 20 to 40 have been measured resulting in greatly improved performance of the new photomultiplier at very low light levels. (auth)

11920 PULSE HEIGHT RESOLUTION OF HIGH GAIN FIRST DYNODE PHOTOMULTIPLIERS. Morton, G. A. (RCA, Princeton, N. J.); Smith, H. M.; Krall, H. R. Appl. Phys. Lett., 13: 356-7(Nov. 15, 1968).

The performance of a new photomultiplier with high-gain GaP(Cs) first dynode is described. The photoelectron statistics are degraded by less than 5% as compared with 20% for conventional multipliers. The improved statistics make it possible, for the first time, to distinguish the emission of one, two, and up to five photoelectrons. (auth)

11921 SPECIAL PHOTOGRAPHIC FILMS FOR RADIOGRAPHY OF RADIOACTIVE PIECES OF VERY HIGH ACTIVITY. Barbier, J. F. (Centre de Recherche, Kodak-Pathe, France). Nucleus (Paris), 9: 275-7(1968). (In French).

The radiography of fuel elements of very high activity from reactors for the detection of ruptures presents many problems, and these are briefly indicated. Photographic emulsions, in general, are too sensitive. The UH-type emulsion and the UM-type for the radiography of rods with activity from 50,000 to 150,000 R/hr and 10,000 to 30,000 R/hr, respectively, are proposed for use in this area. The sensitivity of these two emulsions under different conditions was measured. The results, in graphic form, indicate advantages. (J.S.R.)

11922 LASER BEAM MONITOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1812).

124 drawings.

A monitor is described for measuring power and total energy of a Q-switched pulsed beam laser, with an accuracy of ±6%. The monitor which is a mobile beam sampling device includes a wedged beam splitter which gives good interference averaging, an Al_2O_3 ceramic diffusion disk to improve beam diffusion, a He–Ne laser for alignment, and a photodiode. (For details see TID-4100 Suppl. 4a. See also 21: 12717.) (F.S.)

11923 HIGH RESOLUTION FAST ANALOG-DIGITAL CONVERTER. Patzelt, R. (Electronik-Institut, Seibersdorf, Austria). Acta Phys. Austr., 27: 261-3(1968). (In German).

The resolution of Ge(Li) detectors for γ radiation attains 0.1%. For the taking of spectra therefore, multichannel pulse height analyzers of about 10,000 channels were necessary. A circuit was developed which carries out the conversion in two stages (fast and slow discharge of a condenser). At an operational frequency of 10 MHz the conversion time is a maximum of 40 μ sec for 8,192 channels. The principle yields a shortening of the conversion in N channels by a factor of $2/\sqrt{N}$. (tr-auth)

11924 PRESSURE TRANSDUCER (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE-1814).

1 drawing.

A null-balance pressure transducer is described which is used on 2 rods in the 19-rod cluster fuel element assembly (see CAPE-1814). The 19-rod cluster fuel element assembly is used in the PRTR burnup tests. The transducer measures internal gas pressure buildup during irradiation. Gases within the fuel rod (fission and sorbed gases) produce pressure on one side of a diaphragm keeping an electrical contact closed. Pressure is applied to the secondary side of the diaphragm through a pressure regulating valve until the electrical contact just opens which indicates balanced or internal pressure. (For details see TID-4100 Suppl. 50) (see also 22: 2707.) (F.S.)

11925 TEMPERATURE MEASUREMENTS AND CALIBRATION OF W–Re AND W–Mo THERMOCOUPLES. Ergardt, N. N. Izmer. Tekh., No. 10, 24-7(Oct. 1968). (In Russian).

Tabulated calibration data are given on high-temperature measurements using W–Mo and W–Re thermocouples. In a neutral atmosphere and in a vacuum, the thermocouples operate at temperatures up to 2200 to 2300°C with an order of error (after several hundreds of hours) not exceeding ±10 to 25 degrees. Following 400 hr of annealing at 1400°C in argon the calibration properties of thermocouples varied 30 to 40°C. Calibration properties of W–Re ($^{5}/_{20}$) thermocouples studied in helium atmosphere at 1500°C after 50 hr varied –1.2° after 250 hr they varied up to +7°C. Tests of W–Re ($^{0}/_{24}$) and W–Re ($^{5}/_{26}$) thermocouples at 1000 to 1450°C in a vacuum from 1.33×10^2 to 1.33 n/m^2 during 1000 hr showed that their calibrating properties varied not over +10°. It was shown that irradiation of W–Re thermocouples with thermal neutron flux of 10^{14} neutr/cm^2 sec (10^{18} neutr/m^{2}sec) did not influence calibration properties of W–Re thermocouples during the first six months of exposure. Descriptions of an electrical furnace with a graphite heater designed for calibrating high-temperature thermocouples are included. (R.V.J.)

11926 NANOSECOND TIME-TO-AMPLITUDE CONVERTER. Semkov, L. V.; Shuvalov, R. S. Izmer. Tekh., No. 11, 104(Nov. 1968). (In Russian).

A time-to-amplitude converter with a linear range of 80 nanoseconds and resolving time of $2\tau_0 = 18 \times 10^{-12}$ sec is described. The resolving time which is measured by the method of $\gamma-\gamma$ coincidence $2\tau_0 = 1.6$ per sec and $2\tau_0 = 0.5$ μsec corresponding to a recording efficiency of 86 and 25%. (tr-auth)

Radiation Effects on Instruments and Instrument Components

11927 (HMI-B-75) INVESTIGATION OF THE LOW-FREQUENCY NOISE BEHAVIOR AND SURFACE RECOMBINATION VELOCITY OF MOS STRUCTURES UNDER THE INFLUENCE OF IONIZING RADIATION. Braeunig, D.; Wagemann, H. G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Oct. 1968. 23p. (In German). Dep.

Diode dc currents and diode noise currents of p-n-junctions underneath SiO$_2$ layers were measured comparing the state before and after ionizing irradiation. Within a certain voltage range both quantities show significant maxima, which depend on the state of irradiation and are related to the efficiency of energy states at the Si/SiO$_2$-interface. Different time constants which depend on energy and surface potential may be attributed to these states concerning their noise spectrum. As well 1/f-noise as noise of other type (about 900 cps) may be obtained by variations of surface potential. The efficiency of these states for surface recombination becomes evident simultaneously. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 11443, 11444, 11448, 11757, 11800, 12044, 12073, 12085, 12102, 12131, 12140, 12142, 12148, 12152, 12153, 12194, 12219, 12245, and 13519.

11928 (AEC-tr-6646/4A, pp 1-5) REPAIR OF SINGLE AND DOUBLE BREAKS IN THE DNA OF MICROCOCCUS RADIODURANS EXPOSED TO X RAYS. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Enzyme-treated cells were lysed on an alkaline sucrose gradient and centrifuged to obtain single-stranded DNA. The molecular weight was calculated before and after irradiation. When the cells were lysed and the DNA denatured at different times after irradiation the rate of repair of single breaks could be determined. The repair started immediately and proceeded rapidly after irradiation. By the end of the lag period 70% of the breaks were reconstituted, but the molecular weight was only attained when the DNA complement of the cell had doubled. (H.L.W.)

11929 (AEC-tr-6646/4A, pp 21-4) PHYSICO-CHEMICAL REPAIR OF THYMINE AND DEOXYRIBONUCLEIC ACID EXPOSED TO IONIZING RADIATION. Drasil, V.; Wagner, H.; Juraskova, V. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Thymine dissolved in tritium-labeled water was irradiated. Exchangeable tritium was eliminated after repeated drying and dissolving in stable water; the activity remaining bound in the molecule was then measured. The total amount of tritium incorporated from the water into thymine and the products of its radiolysis were linearly proportional to the radiation dose and the specific activity of the tritium-labeled water. Analogous results were obtained with DNA in tritium-labeled water. (H.L.W.)

11930 (AEC-tr-6646/4A, pp 25-9) RADIATION RECOVERY IN MAMMALIAN CELLS. Elkind, M. M. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Log-phase populations of hamster cells were synchronized with a two-hour exposure to hydroxyurea. Cells were given a fractionated dose of 975 rad of x rays and survival data were recorded in the form of a graph. Results indicate that: repair is weakly dependent on temperature; repair does not require oxygen; new protein synthesis is not required for repair; DNA synthesis is not required for repair; actinomycin D interferes with the expression of a restored capacity for sublethal damage. (H.L.W.)

11931 (AEC-tr-6646/4A, pp 33-5) RECOVERY PROCESSES IN X-IRRADIATED L CELLS: THE ACTION OF ULTRAVIOLET LIGHT AND NUCLEIC ACIDS ANALOGUES ON REPAIR PROCESSES. Han, Antun; Petrovic, Danilo. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

When uv light was delivered a few hours before the first x-ray dose an inhibition in initial recovery occurred similar to that when uv light was delivered after the first x-ray dose. This indicated that the uv effect was not caused by a delay in repair processes, but that it was caused by high uv sensitivity of structures or systems involved in recovery. Recovery was not altered when the replacement of thymine by bromo-uracil in cellular DNA was about 15%. Therefore, recovery in cells containing some bromo-uracil in DNA suggested that the mechanism of enhanced radiosensitivity was not associated with destruction of the mechanism underlying the repair process. Fluoro-uridine affected the synthesis of both DNA and RNA. (H.L.W.)

11932 (AEC-tr-6646/4A, pp 37-42) DELAYED POST-IRRADIATION PHENOMENA IN CULTURES OF MURINE LEUKAEMIC LYMPHOBLASTS L 5178Y: HYPERSENSITIVITY TO LOW DILUTIONS. Beer, J. Z.; Ziembo-Zak, Bogumila; Rosiek, O.; Sablinski, J. M. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Two strains of murine leukemic lymphoblasts differing in radiosensitivity were used. It was found that populations of the sensitive strain that survived several generations after x radiation grew in cultures diluted below the lower limit of logarithmic growth at a rate much lower than the unirradiated populations. The difference in behavior between control and irradiated populations gradually decreased. The phenomenon of hypersensitivity to low dilutions made it possible to reveal a sub-lethal radiobiological lesion that was transferred in irradiation-surviving populations through several tens of generations. Possible causes of the radiobiological lesion and its repair are discussed. (H.L.W.)

11933 (AEC-tr-6646/4A, pp 59-62) FATE OF EXOGENOUS DNA IN UV-IRRADIATED L CELLS. Djordjevic, O.; Kostic, Lj.; Kanazir, D. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Highly polymerized ^{14}C-DNA was extracted from L cells labeled with ^{14}C-thymidine. L cells in the logarithmic phase of growth were uv-irradiated and resuspended in calf serum containing ^{14}C-DNA. The total radioactivity of the medium decreased with incubation time for both normal and irradiated cells, but at a faster rate in non-irradiated cultures. After 24 hours of incubation 80% of non-irradiated cells were labeled; after the same interval in irradiated cultures only 55% of the cells were labeled. The labeled chromosomes found 24 hrs after incubation of nonirradiated and irradiated cells with ^{14}C-DNA indicated strongly that exogenous ^{14}C-DNA or its fragments were incorporated into the DNA of recipient cells. (H.L.W.)

11934 (AEC-tr-6646/4A, pp 65-7) EFFECTS OF EXOGENOUS DNA ON IRRADIATED MAMMALIAN CELLS. Smets, L. A. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Indirect evidence suggested the involvement of DNases in the alterations in DNA metabolism after ionizing radiation. The observed turnover in nascent strands following x-ray treatment of cells includes not only additional synthesis but also breakdown of existing DNA by DNA-splitting enzymes. This turnover will hardly decrease initial damage since during neosynthesis damage in templates could be copied, giving rise to double hit instead of randomly scattered single hit damages. It is proposed that exogenous DNA reverts irradiation effects according to the enzyme capture hypothesis. This hypothesis holds that DNases are occupied by the exogenous substrate after its incorporation and thus are prevented from damaging cellular DNA, either directly or during radiation-induced turnover in nascent strands. The relation of the findings with increased survival observed by others is not yet clear. (auth)

11935 (AEC-tr-6646/4A, pp 69-72) CLONE SIZE DISTRIBUTION OF HeLa CELLS TREATED WITH DNA PRECURSORS. Nias, A. H. W.; Petrovic, Danilo. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

HeLa cells were irradiated and an equimolar solution of the four deoxyribonucleosides was added to the culture medium; the cells were cultured for ten days before fixation. The mean colony counts are tabulated; the percentage survival of the irradiated cells is compared with controls in both treated and untreated groups. With a concentration of 10 μg/ml of nucleosides, the clone size distribution showed no difference between the treated and untreated cell populations and no effect on the proliferation rates. The increased survival percentage obtained with this dosage can therefore be accepted as a true restoration of radiation damage. (H.L.W.)

11936 (AEC-tr-6646/4A, pp 139-45) RESTORATION AND ENHANCEMENT OF ANTIBODY SYNTHESIS BY NUCLEIC ACID DIGESTS AND COLCHICINE. Jaroslow, Bernard N. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

The effects of colchicine on the hemolysin response were tested in x-irradiated and unirradiated rabbits. It was observed that colchicine in progressively increasing amounts stimulated the production of hemolysin at higher rates in both irradiated and unirradiated groups, but the length of the latent period and the duration of antibody production was not modified by colchicine. The role of nucleic acids in these phenomena is discussed. It is believed that cytotoxic agents enhance antibody formation by supplying extra amounts of nucleic acid degradation products that stimulate cells to produce appropriate enzymes for nucleic acid synthesis, and in the presence of antigen the processes leading to antibody production are initiated. (H.L.W.)

11937 (AEC-tr-6646/4A, pp 147-50) RESTORATION OF THE ANTIBODY-FORMING CAPACITY OF IRRADIATED RATS BY MEANS OF NUCLEIC ACIDS. Simic, Miroslav M.; Sljivic, Vojin S. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Rats were given 400 to 600 R of x radiation one or two days before immunization with sheep erythrocytes. They were given nucleic acid preparations from the day of irradiation through four or five days. Results demonstrated that only a fraction of the total damage caused by radiation can be restored by postirradiation treatment with nucleic acids from spleens of homologous donor rats, while the major part of the injury is irreparable under such experimental conditions. The experiment in which both DNA and RNA, isolated from spleen of preimmunized rats, were simultaneously administered after irradiation, strongly suggests that specific preimmunization of prospective nucleic acid donors can increase the degree of restoration of the hemolysin response in irradiated rats. (H.L.W.)

11938 (AEC-tr-6646/4A, pp 155-8) THE EFFECT OF NATIVE ISOLOGOUS DNA ON THE METABOLISM OF DNA IN UV-IRRADIATED L CELLS. Kostic, Lj.; Djordjevic, O.; Kanazir, D. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

L cells were irradiated with uv light in the logarithmic phase of growth. Survival was followed by counting cells cultivated in suspension. For metabolism studies irradiated and nonirradiated cells were plated in a medium containing ^{14}C-DNA. The survival of L cells was about 50% following uv irradiation. When DNA was added to the irradiated culture immediately after irradiation the survival rate was 86% four days after irradiation. (H.L.W.)

11939 (AEC-tr-6646/4A, pp 159-63) EFFECT OF HOMOLOGOUS TESTIS DEOXYRIBONUCLEIC ACID ON THE TESTIS CELL RIBONUCLEIC ACID METABOLISM OF LETHALLY IRRADIATED RATS. Becarevic, Aleksandar; Milosevic, Milorad; Kanazir, Dusan. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Rats were given 850 R of x radiation, and DNA was administered to irradiated and non-irradiated rats. Before killing, each animal was injected intraperitoneally with radioactive phosphate. All animals were sacrificed 29 hrs after irradiation or administration of DNA. Graphs are presented to show metabolic activity of RNA in testis cells. Results showed that irradiation strongly inhibited the capacity of testis cells to incorporate radioactive phosphorus into its RNA, but the decrease of incorporation was particularly pronounced in the ribosomal RNA. However, the radioinduced metabolic lesion was reduced by treatment with native homologous testis DNA. (H.L.W.)

11940 (AEC-tr-6972) PROBLEMS OF DISTRIBUTION AND EXPERIMENTAL EVALUATION OF PERMISSIBLE LEVELS OF ^{137}Cs, ^{90}Sr, AND ^{106}Ru. Buldakov, L. A.; Moskalev, Yu. I. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Russian Book, Atomizdat, Moscow, 1968. 51p. Dep. CFSTI.

Distribution patterns of radioisotopes in mice, rats, guinea pigs, and farm animals were analyzed. The kinetics of ^{137}Cs and ^{90}Sr metabolism in man were also investigated. Secretion of radioisotopes in milk and transmission to progeny were studied. Data were analyzed for the purpose of determining permissible levels of radioisotopes in air, water, and food. Tables are presented to show distribution of ^{106}Ru in various organs of mice and rats and maximum permissible levels of ^{106}Ru in air, water, and food. (H.L.W.)

11941 (AI-AEC-12721, pp 357-61) ADVANCED DEVELOPMENT. (Atomics International, Canoga Park, Calif.).

The reactions of hydrogen atoms and electrons with chromosomes and their principal components were investigated. It was shown that hydrogen atoms react with DNA by addition to template molecules and by abstraction from deoxyribose. The reaction with DNA is temperature sensitive. Hydrogen atoms attack the protein component of chromosomes and do not react with the genes to any great extent. Reactions of electrons with DNA nucleotides lead to anions. In the case of TMP, the anion will readily protonate in aqueous media. A mechanism for base damage in DNA was postulated. (E.R.B.)

11942 (BNWL-SA-2064) MECHANISM OF FLUID AND ELECTROLYTE LOSS FROM THE INTESTINE OF THE IRRADIATED RAT. Sullivan, M. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 28, 1968. Contract AT(45-1)-1830. 10p. (CONF-680826-1). Dep. CFSTI.

From 24th International Congress of Physiological Sciences, Washington, D. C.

Rats were depleted of sodium by maintaining them on a low sodium diet; other rats were given excessive sodium by including 2% NaCl in their drinking water. After 30 days rats on the low sodium diet, stock diet, and high sodium diet were injected intravenously with ^{22}Na. One day later they were given a dose of 1300 R x radiation. The results, shown by means of graphs, show that essentially no ^{22}Na was lost by animals on the low sodium diet until the third day after exposure when damage to the mucosa became severe. The total loss, 23%, occurred by way of urine and feces. The retention data for animals on the low sodium diet paralleled the excretion data, also showing a loss of about 23% after a lethal dose to the lower body. Other experiments showed that radiation decreased both insorption and exsorption. The data indicate that the main reason for sodium accumulation in the irradiated gut lies with the degree of injury to the absorptive process. Accumulation continues following irradiation, whereas it rapidly reaches an equilibrium in control animals and in rats with bile fistulae. Irradiation causes sodium loss initially by inhibiting the reabsorption of secretions that enter the small intestine. The accumulation of these secretions stimulates further electrolyte movement into the lumen which is followed by increased motility and diarrhea. (H.L.W.)

11943 (CONF-671111) RADIOISOTOPES IN MEDICINE: IN VITRO STUDIES. Proceedings of a Symposium held at the Oak Ridge Associated Universities, November 13-16, 1967. AEC Symposium Series 13. Hayes, Raymond L.; Goswitz, Francis A.; Murphy, Beverley E. (eds.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). June 1968. 753p. Dep. CFSTI.

Separate abstracts were prepared for 39 of the papers presented in this symposium discussing the uses of radioisotopes in medical studies. The techniques and applications of isotope dilution, autoradiography, radioimmunoassay, activation analysis, and other tracer techniques are discussed. A subject index and a list of participants are included. (E.R.B.)

For abstracts of individual papers see: 11395, 11428, 11446–11450, 11944–11974, and 13178.

11944 (CONF-671111-, pp 7-41) GENERAL PRINCIPLES OF RADIOIMMUNOASSAY. Yalow, Rosalyn S.; Berson, Solomon A. (Veterans Administration Hospital, Bronx, N. Y.).

Theoretical and practical aspects of radioimmunoassay are discussed with specific reference to optimal conditions that provide maximal sensitivity or maximal precision, selection of antisera, labeling of peptide hormones at high specific activity, limitations on attainable specific activities in terms of available isotopic abundances and decay catastrophe of highly labeled molecules, and specificity of radioimmunoassay. (auth)

11945 (CONF-671111-, pp 43-57) PROTEIN BINDING AND ITS APPLICATION IN THE ASSAY OF NONANTIGENIC HORMONES: THYROXINE AND STEROIDS. Murphy, Beverley E. Pearson (Queen Mary Veterans Hospital, Montreal (Quebec). McGill Univ., Montreal (Quebec)).

The property of protein binding was used to assay a number of nonantigenic hormones in a manner similar to that of radioimmunoassay. Naturally occurring proteins with specific binding sites for these substances were used in place of immunologically induced antibodies. Thyroxine and eight steroids have been measured in this way. Clinical studies have validated the use of these assays as routine procedures that are rapid, sensitive, and free from the effects of drugs. (auth)

11946 (CONF-671111-, pp 59-100) THEORETICAL ASPECTS OF "SATURATION" AND RADIOIMMUNOASSAY. Ekins, R. P.; Newman, G. B.; O'Riordan, J. L. M. (Middlesex Hospital, London (England). Inst. of Nuclear Medicine).

Equations describing the response curves observed in saturation assay (including radioimmunoassay) techniques were developed. These embrace situations in which one or more species of binding site are involved and in which the tracer hormone differs in reaction energy from that of the inactive hormone present in the system. In certain circumstances an endogenous hormone may differ markedly in reaction energy from the hormone used as standard, but, nevertheless, the two may yield dilution curves that are virtually indistinguishable. In such situations large factorial errors may unknowingly be made in estimates of endogenous hormone. The equations can also be used to define conditions of maximum sensitivity. Experimental errors made in the estimation of free-to-bound (or bound-to-free) ratios depress assay sensitivity and affect the composition of optimum incubation mixtures. Equations by which the optimum composition for maximum assay sensitivity can be defined, provided an estimate of such experimental errors can be made, are presented. The maximum sensitivity attainable under these circumstances can also be calculated. (auth) (TSS)

11947 (CONF-671111-, pp 101-13) USE OF RADIOACTIVE ISOTOPES IN MEASUREMENTS OF FLOW RATES IN METABOLIC PATHWAYS. Denton, R. M.; Randle, P. J. (Bristol Univ. (England)).

Measurements of rates of flow in metabolic pathways in tissues in vitro have proved useful in studying effects of hormones on metabolism and in defining control points and control mechanisms. Where rates of flow are slow, as in protein synthesis, or where pathways are complex, as in glucose metabolism in adipose tissue, isotope methods have proved useful. To measure absolute rates of flow, one must measure the specific activity of tissue precursors or show that they have the same specific activity as medium precursors. Previously, paper, thin-layer, or ion-exchange chromatography was used to separate intermediates for assay of radioactivity. Restrictions on loading, interference by salt, and poor resolution were major disadvantages of these methods. New methods were developed in which enzymes are used either to release the isotope from particular metabolites for counting or to facilitate chromatographic resolution. They were used to measure the specific activities of glucose-6-phosphate, glycerolphosphate, citrate (acetate and oxaloacetate moieties), and acetyl-CoA in rat heart muscle and to estimate radioactivity in glycerol formed by rat heart or rat epididymal adipose tissue from uniformly labeled ^{14}C–glucose. With this method it was possible to obtain estimates of the rate of reesterification in rat heart and to show that this is increased in alloxan diabetes; to measure transient changes in glycogen synthesis and breakdown during the onset of acetate oxidation in rat heart; and to study the equilibrium between acetyl-CoA and citrate pools in rat heart during acetate oxidation. (auth)

11948 (CONF-671111–, pp 115-28) FACTORS INFLUENCING INSULIN RELEASE IN VITRO. **Grodsky, Gerold M.; Curry, Donald L.; Bennett, Leslie L.; Lecharny, Brigitte (California Univ., San Francisco. Medical Center).**

Insulin synthesis and release were studied in vitro using the isolated perfused pancreas of the rat. Response of the pancreas to a continuous perfusion with a constant concentration of glucose was multiphasic. Release was rapid after a few seconds, but the rate declined rapidly within minutes. By 10 min secretion rates increased again and continued to do so during 60-min experiments. The early release was not influenced by inhibition of protein synthesis with puromycin whereas the latter release phase was. Thus glucose may stimulate both release of preformed insulin and later the de novo synthesis of the hormone from amino acids. Mathematical analysis of the release pattern during the early phase indicated that the decrease in insulin secretion noted after the first few minutes may be caused by an intracellular feedback inhibition. Alternately, exhaustion of a small compartment of easily releasable insulin was possible. A similar multiphasic response of the pancreas was shown to occur in vivo during a continuous infusion of arginine, that indicated that this pattern of response was not solely a phenomenon of the in vitro preparation. Tolbutamide in vitro also caused a prompt release of insulin followed by a secondary inhibitory phase. Subsequent infusion of tolbutamide caused no secondary increase in secretion rate, that indicated that this agent, in contrast to glucose, has no significant effect on insulinogenesis. The action of tolbutamide was not inhibited by puromycin. Glucagon potentiated glucose stimulation during the first 10 min and may have acted primarily to reduce the time or intensity of the period of feedback inhibition. The possibility that glucagon could act to facilitate insulin release from another compartment or facilitate refilling of the glucose-sensitive compartment was not excluded. It was concluded that agents may act on the pancreas to influence insulin release by several different phenomena: Stimulation of release of preformed insulin from a relatively small compartment, reduction of secondary inhibition or increased refilling of the compartment, stimulation of insulinogenesis, or maintenance of membrane viability. (auth)

11949 (CONF-671111–, pp 129-43) PHYSIOLOGIC ROLE OF GLUCAGON. **Buchanan, Keith D.; Vance, James E.; Williams, Robert H. (Washington Univ., Seattle).**

The physiologic role of glucagon cannot be stated with certainty at the present time. Many studies involving glucagon have used doses of glucagon that may be described as pharmacologic rather than physiologic. Despite this it seems probable from these studies that glucagon has a role in glycogenolysis and gluconeogenesis. Glucagon-deficiency states in the fowl suggest that glucagon is of importance in maintaining the blood glucose levels. Glucagon was also found to stimulate insulin secretion. In the immunoassay for glucagon, difficulties caused by the extremely low levels of circulating glucagon, the degradation of glucagon by serum, and cross-reacting gut material that has an immunological resemblance to pancreatic glucagon were encountered. The degradation of glucagon in the immunoassay can be prevented by the use of Trasylol, but many reports of serum glucagon levels by immunoassay before the use of Trasylol may be erroneous. So far the immunoassay has shown only two factors that stimulate pancreatic glucagon, namely, pancreozymin and amino acids, but has not yet accurately defined the role of glucagon during glycogenolysis or gluconeogenesis. The function of the glucagonlike material in the gut has not been ascertained, and it is not known how similar it is to pancreatic glucagon, although preliminary work suggests that it is not identical. (auth)

11950 (CONF-671111–, pp 145-63) NORMAL AND ABNORMAL SECRETION OF GROWTH HORMONE IN MAN. **Daughaday, William H. (Washington Univ., St. Louis. School of Medicine).**

The radioimmunoassay of growth hormone has been of great importance in experimental and clinical endocrinology because heretofore indirect indexes of growth-hormone secretion were insensitive and misleading. Normally plasma growth hormone is low in the morning after awakening and rises after physical activity. Peaks of growth-hormone secretion are frequent three to four hr after meals and in the early hours after the onset of sleep. Although hypoglycemia is an important stimulus for growth-hormone secretion, the relation between blood sugar and growth-hormone secretion is not a simple one. The growth-hormone response to a number of stimuli is facilitated by estrogens and inhibited by corticosteroids. Response to provocative stimuli may be impaired in certain patients with obesity and hypothyroidism. The diagnosis of growth-hormone deficiency in man cannot be made unequivocally in most cases with a single fasting plasma sample but requires the measurement of plasma growth hormone after insulin-induced hypoglycemia or arginine infusion. Preliminary evidence would suggest that certain dwarfed children may be functionally deficient in growth hormone despite measurable responses to arginine infusion. The diagnosis of organic hypersomatotropism requires both the demonstration of elevated levels of plasma growth hormone and the failure of glucose to lower plasma growth hormone below 5 ng/ml. Measurements of plasma growth hormone have provided the most reliable guide to the effectiveness of treatment of acromegaly. In the past, treatment with conventional doses of external radiation failed to control the disease. Local ablative therapy has been more effective. There is no evidence that elevations of plasma growth hormone contribute to the diabetic state in the absence of acromegaly. (auth)

11951 (CONF-671111–, pp 165-83) RADIOIMMUNOASSAY OF LUTEINIZING AND FOLLICLE-STIMULATING HORMONES IN HUMAN SERUM. **Odell, W. D.; Swerdloff, R. S. (Harbor General Hospital, Torrance, Calif. California Univ., Los Angeles. School of Medicine).**

The bulk of our knowledge concerning physiology of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) was gained by bioassay of concentrates of 24- to 72-hr urine pools or of large volumes of blood. The development of radioimmunoassays for human follicle-stimulating hormone (HFSH) and human luteinizing hormone (HLH) has permitted quantification of these hormones in less than 1 ml of serum or plasma from eugonadal men or women. Antisera against HRSH and HLH were obtained by immunization of rabbits with impure pituitary preparations containing HLH and HFSH or with human chorionic gonadotropin (HCG). The majority of antisera against HFSH were not specific when used in a radioimmunoassay (showing almost equal displacement of ^{131}I–HFSH by HFSH or HLH. Specific radioimmunoassays for HLH and HFSH were developed by screening a number of antisera. Specificity was proved by good correlation of immunoassay and bioassay potency estimates of gonadotropin preparations of varying degrees of purity, by the similarity in the dose-response curves in the immunoassay of such gonadotropin preparations, and by low degree of cross-reaction of purified preparations of other carbohydrate-containing polypeptide hormones. Ranges of serum concentrations of HLH and HFSH were determined for eugonadal and castrate men and women and for prepubertal children. (auth) (TSS)

11952 (CONF-671111–, pp 185-206) RADIOIMMUNOASSAY OF HUMAN THYROTROPIN. **Odell, W.; Vanslager, D. L. (Harbor General Hospital, Torrance, Calif. California Univ., Los Angeles. School of Medicine); Bates, R. (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.).**

Radioimmunoassays of polypeptide-protein hormones give greater sensitivity and precision than bioassays. Data collected since 1962 reflecting experiences with development and use of the radioimmunoassay of human thyroid-stimulating hormone (HTSH) are reviewed. Antisera were prepared in rabbits against both pure and impure preparations of HTSH. Purified HTSH was labeled with ^{131}I and antibody-bound ^{131}I–HTSH separated from free by the double antibody technique. All antisera showed extensive cross-reaction with human chorionic gonadotropin (HCG) and human luteinizing hormone (HLH). Thus antisera were absorbed with excess HCG to make the immunoassay specific. Under these conditions the radioimmunoassay was highly specific for HTSH. Potency estimates by immunoassay were in good agreement with those obtained by bioassay for nine preparations ranging in HTSH content by bioassay from 0.147 to 9.5 international units per milligram. The HTSH concentrations in sera from euthyroid subjects of all ages greater than one yr and of both sexes contained an average of 5.2 microunits/ml (range, 2.8 to 9.4). Sera from euthyroid subjects receiving large doses (over 200 μg/day) of triiodothyronine contained less than 2.5 microunits/ml. Thirteen euthyroid subjects were treated for 7 to 28 days with methimazole or propylthiouracil. Only four had elevations in serum HTSH. No changes in HTSH concentrations have been observed in response to glucose administration, meals, exercise, fasting, fever, surgery, cold exposure, arginine, or vasopressin administration. Serum HTSH concentrations in patients with primary hypothyroidism were always elevated and ranged from 10 to 240 microunits/ml. Sera from patients with hyperthyroidism of any etiology contained low or undetectable amounts of HTSH. (auth) (TSS)

11953 (CONF-671111-, pp 207-29) RADIOIMMUNOASSAY OF PARATHYROID HORMONE: STUDIES OF THE CONTROL OF SECRETION OF THE HORMONE AND PARATHYROID FUNCTION IN CLINICAL DISORDERS. **Potts, J. T. Jr.; Deftos, L. J.; Buckle, R. M.; Sherwood, L. M.** (National Heart Inst., Bethesda, Md.); **Aurbach, G. D.** (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.).

The radioimmunoassay for bovine parathyroid hormone (PTH) was used to study the control of secretion of the hormone in the cow. Hormone concentration changes rapidly after an increase or decrease in blood calcium concentration (induced by infusions of calcium or ethylenediamine tetraacetic acid); maximum increase in hormone concentration in acute stimulation is threefold to sixfold and after chronic stimulation it is as great as 50-fold. There is a linear inverse correlation between calcium and PTH for ranges of blood calcium from 4 to 12 mg/100 ml. Half-life of the hormone in plasma is 10 to 25 min. These large and rapid changes in concentration of hormone reflect the close regulation of hormone secretion by blood calcium and support the concept that parathyroid hormone is important in minute-to-minute regulation of blood calcium. Use of the immunoassay to study parathyroid dysfunction in man was possible despite the limitations of lower sensitivity. (Human PTH differs immunologically from bovine PTH.) Application of the assay confirms that production of excessive parathyroid hormone is involved in ectopic hyperparathyroidism. Preliminary studies show that in primary hyperparathyroidism secretion of hormone is autonomous whereas, in secondary hyperparathyroidism, particularly chronic renal disease, the increased rate of hormone secretion can still be suppressed by raising blood calcium. These studies suggest that the immunoassay will have increasingly wider use in defining states of parathyroid dysfunction in man. (auth)

11954 (CONF-671111-, pp 251-72) ACTH RADIOIMMUNOASSAY: INTERPRETATION, COMPARISON WITH BIOASSAY, AND CLINICAL APPLICATION. **Orth, David N.; Island, Donald P.; Nicholson, Wendell E.; Abe, Kaoru; Woodham, Jean P.** (Vanderbilt Univ., Nashville, Tenn. School of Medicine).

The molecular specificity of several antibodies developed to adrenocorticotropic hormone (ACTH) was studied with the technique of radioimmunoassay. It was shown that animals immunized with ACTH produced a variety of antibodies that reacted with different parts of the ACTH molecule. Sensitive radioimmunoassay systems were developed that were quite specific, one for the N-terminal portion of the ACTH molecule and the other for the C-terminal portion. There was good agreement between the levels of ACTH in human pituitary glands as determined by bioassay and by both N-terminal and C-terminal radioimmunoassay. In tumors from patients with the ectopic ACTH syndrome, however, a superabundance of C-terminal immunoreactive ACTH was found, demonstrating that in certain circumstances the apparent amount of ACTH measured by radioimmunoassay may depend upon the molecular specificity of the antibody used in the assay. With an efficient method for extracting ACTH and β-melanocyte-stimulating hormone (MSH) from 10 to 15 ml of plasma, as little as 5 pg of ACTH per milliliter of plasma was measured with a three-point dilution curve. The normal range of immunoreactive ACTH values (<120 pg/ml) was somewhat higher than that determined by bioassay (<50 pg/ml) when pure human ACTH (100 international units/mg) was used as a reference standard in both assays. Simultaneous radioimmunoassay measurements of ACTH and its companion hormone, β-MSH, have shown that, in most circumstances, the level of β-MSH was correlated with that of ACTH in plasma and even in ACTH- and MSH-producing tumors arising from a variety of tissues. This suggests that a common mechanism may be involved in the production of both ACTH and β-MSH. (auth)

11955 (CONF-671111-, pp 273-91) INTERACTION OF THE THYRONINES AND THEIR BINDING PROTEINS IN SERUM. **Tauxe, W. Newlon** (Mayo Clinic, Rochester, Minn.); **Kusakabe, Tsunesuke** (Minnesota Univ., Rochester. Mayo Graduate School of Medicine).

A large number of clinical tests have been developed on the basis of the interactions of the thyronine-binding proteins found in the blood. As more data about the nature of these binding proteins and these tests are accumulated, it becomes obvious that some highly complex mechanisms of interactions are involved. This paper presents a review of both paper and starch-gel electrophoretic patterns of the thyronine-binding proteins, discusses some factors that influence erythrocyte and resin uptakes of triiodothyronine, and gives a brief evaluation of these tests. (auth)

11956 (CONF-671111-, pp 293-313) THYROXINE BINDING IN SERUM. **Sterling, Kenneth** (Veterans Administration Hospital, Bronx, N. Y. Columbia Univ., New York. Coll. of Physicians and Surgeons).

Determinations of the binding capacities of the major thyroxine carriers in human serum were made. The findings indicated that in health and in disease these protein carriers are important determinants of the free thyroxine fraction or diffusible moiety of the hormone. In many instances of thyroid disease, liver disease, and nonthyroidal illness, variation in thyroxine-binding alpha globulin (TBG) appeared to be a more important determinant than variation in thyroxine-binding prealbumin (TBPA). Significant reductions of TBG capacity were observed in thyrotoxicosis, cirrhosis of the liver, and major nonthyroidal illness, in addition to diminutions of TBPA. The elevated free thyroxine fraction was associated with short biologic half-time. The findings were compatible with the concept that free thyroxine is an important determinant of removal rate and that the physiologic activity depends upon the concentration of unbound hormone. (auth)

11957 (CONF-671111-, pp 315-24) THYROXINE-BINDING GLOBULIN: GENETIC ALTERATIONS IN CONCENTRATION. **Seal, Ulysses S.** (Veterans Administration Hospital, Minneapolis, Minn.); **Nikolai, Thomas F.** (Marshfield Clinic and Foundation, Wis.); **Jones, John E.** (West Virginia Univ., Morgantown. Medical Center).

Two unrelated families with either reduced or no thyroxine-binding globulin (TBG) and one family with elevated TBG were studied. Eighteen hemizygous male members of the kindred with low TBG had no detectable TBG binding of thyroxine (T_4) or triiodothyronine (T_3). In contrast, 21 heterozygous female members had TBG with the concentration varying from very low to normal but always present. The male members had low protein-bound iodine (PBI) values (mean, 2.1 μg/100 ml) and high resin T_3 uptakes (mean, 61%). Estrogen treatment of a man elicited no detectable TBG. The female members presented a more variable picture with TBG varying from 2 to 20 μg/100 ml. A newborn son of an affected woman had no detectable TBG in a cord blood sample, which indicated that TBG was not essential for normal fetal development and that the protein did not cross the placenta. The family with high TBG included two male and seven female members with elevated TBG, PBI, and serum T_4 content. The resin T_3 uptake was decreased. The administration of estrogen to a man and two women resulted in a further significant increase in TBG. Thyroxine degradation rates (55 μg of T_4–iodine per day) were normal in affected members of the families with low and high TBG, in agreement with their clinically euthyroid status. Other serum proteins, including albumin, T_4-binding prealbumin (TBPA), and corticosteroid-binding globulin, were normal in the high and low families. No evidence of clinical disease associated with these TBG abnormalities has become apparent. Analysis of the three kindred indicates that the high and low traits are transmitted by X-chromosome-linked codominant inheritance. (auth)

11958 (CONF-671111-, pp 325-38) BINDING OF ESTROGENS AND TESTOSTERONE IN HUMAN PLASMA. **Rosner, William; Kelly, William G.; Deakins, Susan M.; Christy, Nicholas P.** (Roosevelt Hospital, New York. Columbia Univ., New York. Coll. of Physicians and Surgeons).

The presence in human plasma of beta globulins that bind estradiol and testosterone was established by paper electrophoresis. In addition, plasma contains an interalpha globulin that binds testosterone. Purification of the beta globulin that binds estradiol by ion exchange and gel-filtration chromatography revealed that the single beta-globulin band on paper electrophoresis can be resolved into at least two proteins. (auth)

11959 (CONF-671111-, pp 351-63) IRON-BINDING GLOBULIN. **Cook, J. D.; Finch, C. A.** (Washington Univ., Seattle. School of Medicine).

Measurements of plasma iron and its transport protein have contributed much to our present understanding of erythropoiesis. Although the plasma contains only a minute fraction of total body iron, it provides the communication between widely separated intracellular iron compartments. In particular, it provides the essential link in the continuous recycling of iron through successive red-cell generations. (auth)

11960 (CONF-671111-, pp 365-79) VITAMIN B_{12} BINDING PROTEINS AND THEIR ANTIBODIES. **Hall, Charles A.; Finkler, Alexander E.** (Veterans Administration Hospital, Albany, N. Y.).

The Intrinsic Factor, a glycoprotein that participates in the absorption of vitamin B_{12}, (B_{12}), has now entered laboratory medicine. Since it is absent in pernicious anemia, its assay is used to make the diagnosis of pernicious anemia. The most common form of assay is derived from the blockage of intrinsic-factor binding in gastric juice by one of the autoantibodies to intrinsic factor. Transcobalamin II and II (TC I and II) are the known B_{12} transport substances in normal plasma. Other substances in plasma bind B_{12} but probably not in normal circumstances. Since there is a shift in the relative abundance of TC I and II in myeloproliferative disease, their measurement can be used diagnostically. Vitamin B_{12}-binding proteins can be used as a reagent in isotope, dilution assays of B_{12}. Intrinsic factor now seems to be the best binder. (auth)

11961 (CONF-671111-, pp 381-94) QUANTITATIVE ASSAY OF INTRINSIC FACTOR SECRETION IN HUMANS. **Sullivan, Louis W.** (Boston Univ., Mass.).

A quantitative in vitro assay for human intrinsic factor is discussed. The assay is based upon the observation that the uptake of radioactive vitamin B_{12} by guinea pig ileal mucosa is facilitated in a stoichiometric manner by normal human gastric juice or hog intrinsic factor but not by gastric juice from patients with pernicious anemia. There is excellent correlation between the in vitro assay and in vivo activity of the gastric juice in enhancing vitamin B_{12} absorption in patients with pernicious anemia. The assay has the advantages that it measures the net result of both properties of intrinsic factor: binding of vitamin B_{12} and transfer of the vitamin to specific intestinal receptors. (auth)

11962 (CONF-671111-, pp 413-33) RADIOENZYMATIC ASSAYS FOR FOLIC ACID, FOLIC ACID ANTAGONISTS, AND FOLATE REDUCTASE. **Rothenberg, Sheldon P.** (New York Medical Coll., New York).

The enzymic reaction in which folate reductase reduces folic acid to tetrahydrofolic acid with reduced triphosphopyridine nucleotide as the cofactor was adapted as a radioassay for folic acid. In this system, ^{3}H-folic acid and unlabeled folic acid compete for a rate-limiting quantity of the enzyme, and, as the concentration of unlabeled folate increases, less of the ^{3}H-folate is converted to tetrahydrofolate. This inhibitory effect of unlabeled folate on the reduction of ^{3}H-folate was quantitated, and a standard curve was constructed. When serum containing folic acid was similarly assayed, the concentration of the folate was determined by reference to the standard curve. Although there was no difference in the serum endogenous folic acid concentration in normal subjects and in subjects with folate deficiency when measured by this radioassay, the clearance of folic acid after intravenous injection was determined, and this separated normal subjects from patients with folate or B_{12} deficiency. The clearance rate was also more rapid in the patients with folate deficiency than in patients with B_{12} deficiency, although an overlap was observed in a few cases. The methodology developed for the folate radioassay was also applied in measuring the folic acid antagonist, methotrexate, since this is a specific inhibitor of folate reductase. The drug can now be measured in serum, as well as in tissue and cell extracts, with an extreme degree of sensitivity. The radioassay system has also been used to determine the activity of the enzyme in tissue and cell extracts. Since a substrate level as low as 0.25 ng of ^{3}H-folate can be quantitatively monitored, the sensitivity for measuring low-enzyme concentrations is much greater than that obtained with spectrophotometric methods, that generally require much higher substrate and cofactor concentrations. (auth)

11963 (CONF-671111-, pp 491-9) POTENTIAL APPLICATIONS OF ACTIVATION ANALYSIS IN CLINICAL MEDICINE. **Tang, C. W.; Tomlinson, R. H.** (McMaster Univ., Hamilton (Ontario)).

Activation analysis as a tool for the investigation of trace elements in clinical medicine is reviewed in relation to other methods. Some of the difficulties and advantages of activation analysis are discussed. Although activation analysis is not currently used on a routine basis for any clinical purposes, several procedures, such as the determination of protein-bound iodine, are discussed. Applications to epidemiological studies, such as air pollution, and uses in toxicology where, particularly in the case of arsenic poisoning, it may become the preferred method are considered. Activation analysis may also be used to obtain information similar to that obtained by the tracer techniques of nuclear medicine. Although the activation analysis would not be as simple, it could be used without the irradiation of the patient. (auth)

11964 (CONF-671111-, pp 501-14) STABLE ISOTOPES AS BIOLOGICAL TRACERS. **Lowman, James T.; Heagan, Beatrice; Krivit, William** (Minnesota Univ., Minneapolis. Hospitals).

The use of radioactive isotopes for clinical research in normal children and other population groups was criticized. In vivo usefulness of stable isotopes as tracers using activation analysis was studied. Iron-58 in human plasma can be detected and quantitated in concentrations as low as 0.0125 μg/ml. Stable ^{58}Fe and radioactive ^{59}Fe were studied simultaneously in humans and found to have identical clearance patterns. Iron clearance rates in newborns were determined with this technique. Colloidal-gold clearance rates as a measure of the reticuloendothelial capacity were described. Stable colloidal ^{197}Au was injected into children and blood samples drawn at appropriate intervals. The samples were activated and clearance rates were determined. The early developmental procedures for ^{50}Cr as a red-cell tag were completed. This stable isotope requires a radiochemical separation after activation. This separation is accomplished with a mixed Dowex-1 and Dowex-50 column with nitric and glacial acetic acid elutions. Calcium kinetics in children were studied by several investigators; this procedure and some general considerations regarding stable isotopes as biological tracers are discussed. (auth)

11965 (CONF-671111-, pp 515-22) TRACE ELEMENTS. **Bethard, W. F.** (Gulf General Atomic, Inc., San Diego, Calif.).

The mechanism(s) by which trace elements effect their various metabolic roles in biological systems will inevitably be clarified in the future. Their functions can presently be classified as electrochemical, catalytic, structural, and miscellaneous. Analytic methods, upon which increased knowledge of trace-element function is ultimately dependent, are improving rapidly and remarkably. At least eleven methods, including activation analysis, are now known with applicable sensitivity and precision. Sources of analytic error must be anticipated and considered carefully in dealing with elements in trace quantities. Ultimately investigators must agree on the optimum method of expressing analytic results. (auth)

11966 (CONF-671111-, pp 565-77) METABOLIC CHANGES ASSOCIATED WITH PHAGOCYTOSIS OF PARTICLES BY HUMAN LEUKOCYTES DURING BACTERIAL INFECTIONS. **Kaihara, Shigekoto; Wagner, Henry N. Jr.** (Johns Hopkins Medical Institutions, Baltimore, Md.).

Among the metabolic changes that take place in polymorphonuclear leukocytes during phagocytosis is stimulation of glucose metabolism by way of the hexose monophosphate shunt. This can be demonstrated by measuring the radioactive $^{14}CO_2$ released when ^{14}C-glucose is used as substrate in the incubation media. The stimulation of $^{14}CO_2$ production when polystyrene particles were incubated with whole blood was evaluated as a possible index of abnormalities of the phagocytic process in human diseases. Two milliliters of whole blood was incubated for 1 hr with 10 micromoles of ^{14}C-labeled glucose and a number of polystyrene particles that exceeded the phagocytic capacity (5.3×10^7 per cubic millimeter). The increase of $^{14}CO_2$ production was compared with $^{14}CO_2$ production of blood incubated without particles. In normal subjects $^{14}CO_2$ production per milliliter of whole blood was found to be proportional to the number of polymorphonuclear leukocytes per cubic millimeter, and if this was corrected for the number of leukocytes, a reproducible index was obtained. In four patients with shigellosis and three patients with pneumonia, this index was higher than in normal persons. (auth)

11967 (CONF-671111-, pp 579-88) LYMPHOCYTE TRANSFORMATION: A BASIS FOR IN VITRO HISTOCOMPATIBILITY TESTING. **Bach, Fritz H.** (Wisconsin Univ., Madison).

One-way stimulation is achieved in mixed leukocyte culture (MLC) tests if cells of one subject are treated with Mitomycin-C and the response is assayed by studying the incorporation of radioactive thymidine. Treated cells cannot incorporate tritium-labeled thymidine but can stimulate untreated allogeneic cells to do so. With this method 29.2% of 184 sibling cell mixtures have not stimulated, whereas all of 226 unrelated cell mixtures have stimulated. Nonstimulators are clearly separated from stimulators. Genetic analysis of these data, based on predicted percentages of nonstimulators (for different genetic relationships) depending on the number of loci and alleles involved, suggests that reactivity in MLC tests is controlled by a single locus with 15 or more alleles. Siblings that do not stimulate (MLC-identical siblings) are also identical for the majority of leukocyte antigens detected by antisera of Amos. The MLC-identical siblings show prolonged skin-graft survival (15 to 36 days) compared with siblings whose cells stimulate in MLC tests (11 to 13 days). The previous studies, combined with the findings of Silvers, Wilson, and Palm, that stimulation in MLC tests in rats only occurs when two rats differ at the major histocompatibility locus, suggests that MLC tests in man measure antigenic differences at the major histocompatibility locus in man. (auth)

11968 (CONF-671111-, pp 589-606) USE OF RADIOIMMUNOELECTROPHORESIS FOR THE STUDY OF SERUM PROTEIN AND ANTIBODY SYNTHESIS IN VITRO. Thorbecke, G. J.; Hochwald, G. M. (New York Univ., N. Y. School of Medicine).

Two methods can be used in the study of ^{14}C-amino acid incorporation by tissues into serum proteins. One approach requires isolation of the radioactive product from the culture fluids. The other method uses autoradiography of immunoelectrophoretic patterns. The latter method cannot readily be used for quantitation but provides a rapid assay for production of a variety of proteins by tissues or cells in vitro. It was used successfully in the study of ontogeny of the immune response, site of production of acute phase proteins, sites of synthesis of serum proteins associated with the complement system, and in the demonstration of serum protein production by established tissue-culture cell lines. (auth)

11969 (CONF-671111-, pp 607-19) USE OF RADIOIODINE IN IMMUNOLOGICAL STUDIES OF TUMORS. Yagi, Yasuo (Roswell Park Memorial Inst., Buffalo, N. Y.).

Radioiodinated antibodies and radioiodinated antigens are often used in immunologic studies of normal and malignant tissues. The localization of radioiodinated antitissue antibodies in vivo was useful in studying the antigenic components in blood vessels and on the surface of cells that are in good contact with the circulation. Radioiodinated anticarcinogen antibody was used extensively in the study of carcinogen-binding components in livers of rats treated with 2-acetylaminofluorene. A gradual loss of carcinogen-binding components during carcinogenesis was indicated by the studies on the localization of injected antibody in livers or hepatomas of rats treated with carcinogen in vivo and on the fixation of antibody on sections of these tissues in vitro. Three carcinogen-binding components in liver microsomes were identified by immunoelectrophoresis with a mixture of antirat liver serum and ^{131}I-labeled anticarcinogen antibody. (auth)

11970 (CONF-671111-, pp 621-32) RATIONALE AND BIOCHEMISTRY OF TRITIATED THYMIDINE AS A CELL LABEL. Rubini, J. R.; Matsui, K. (Miami Univ., Coral Gables, Fla. Hematology Research Lab. Veterans Administration Hospital, Coral Gables, Fla.).

Tritium-labeled thymidine (^{3}H−TDR) is a widely used label for studying cell proliferation and deoxyribonucleic acid (DNA) synthesis. The rationale for the use of this nucleoside to label cells is based upon the utilization of this thymine compound for synthesis of new DNA−thymine so that ^{3}H−TDR serves as a specific precursor for ^{3}H−DNA synthesis. Newly labeled ^{3}H−DNA can be detected within individual cells by using autoradiography with excellent resolution. Studies of ^{3}H−TDR-labeled cell populations, their turnover and fate, have yielded much new information. Biochemical extraction and liquid scintillation counting of labeled DNA after exposure of cells to ^{3}H−TDR has also provided valuable and correlative new information on DNA biochemistry. In spite of the effective incorporation of some ^{3}H−TDR into new DNA, most of the nucleoside is degraded and excluded from ongoing endogenous DNA synthetic pathways. The efficiency of ^{3}H−TDR as a DNA label can be improved by varied biochemical maneuvers. Heavier labeled DNA can be achieved with these efforts and may be useful for future research. (auth)

11971 (CONF-671111-, pp 633-60) HIGH-RESOLUTION AUTORADIOGRAPHY AND ITS APPLICATION TO IN VITRO EXPERIMENTS: SUBCELLULAR LOCALIZATION OF ^{3}H-ESTRADIOL IN RAT UTERUS. Stumpf, Walter E. (Chicago Univ., Ill.).

In autoradiography, labeled compounds are used to provide information concerning their cellular and subcellular distribution under in vivo or in vitro conditions. It is most successful in combination with biochemical or physiological studies by providing a different method or another approach to answer the question. Owing to the high sensitivity of photographic emulsion and the need for tissue preparation with section and film mounting, the technique is prone to artifact formation. In autoradiography, minimizing or elimination of translocation, the most serious and most frequent artifact, is accomplished by a method based on the use of frozen sections, freeze-dried and dry mounted on photographic emulsion; this method excludes liquid fixation, dehydrating and clearing fluids, embedding media, adhesives, and thawing of frozen sections. High histological resolution of unfixed and unembedded sections can now well be provided by low-temperature tissue preparation with cryostatic cutting of 0.5- to 1-μ thin sections and freeze-drying at dry-ice temperatures by cryosorption pumping. With an autoradiographic method that excludes translocation and redistribution, useful results can be obtained not only with radioactive substances that are covalently bound but also with weak binding or unbound substances. This was well documented in the study of the subcellular in vivo distribution of ^{3}H−estradiol in the uterus and its deviation from results obtained by techniques that did not control translocation. In vitro experiments with rat uterus demonstrated different subcellular binding sites of the same hormone, dependent on the incubation temperature, thus confirming the localization of biochemically isolated nuclear 5 S and extranuclear 9.5 S binding factors. In these applications, dry-mounting high-resolution autoradiography with freeze-dried frozen sections can be useful as a control for distribution studies of substances with cell fractionation. (auth)

11972 (CONF-671111-, pp 661-77) ELECTRON-MICROSCOPE AUTORADIOGRAPHY. de Harven, Etienne (Sloan-Kettering Inst. for Cancer Research, New York).

A critical review of problems involved in electron-microscope autoradiography (EMAR) is presented. Radiolysis of tritium-labeled compounds, lethal effects of β radiation on cells, and interference with their growth rate are considered. Problems of fixation for EMAR as well as the quantitative evaluation of the results are discussed. A few successful applications of methods dealing with studies of cell metabolism, virus−host-cell relations, effects of drugs, and use of ^{125}I and ^{32}P are reviewed. Finally, the concept of a nonmetabolic EMAR is presented and illustrated by the nuclear labeling of tissue-culture cells incubated with ^{3}H-actinomycin D. (auth)

11973 (CONF-671111-, pp 679-94) USES AND PITFALLS OF CHROMOSOMAL LABELING. Rowley, Janet D. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill.).

Autoradiography, when applied to the analysis of the pattern of DNA synthesis in human chromosomes, reveals a marked asynchrony in one of the two X chromosomes in the normal human female. The single X chromosome in the normal male shows no asynchrony. However, additional X chromosomes in either the male or the female are late labeling, as are morphologically abnormal X chromosomes. Reproducible labeling patterns were identified for some of the autosomal groups, permitting the identification of the chromosome pairs in the B-, D-, and E-group autosomes. This analysis of labeling patterns was applied to a family in which the mother had 45 chromosomes, with a D/D translocation chromosome replacing two D-group chromosomes; her daughter also had only 45 chromosomes, but she had a B/D translocation chromosome replacing one B- and one D-group chromosome. With autoradiography it was shown that the mother's cells lack one D_1 and one D_2 chromosome that form the D/D translocation chromosome. Autoradiographic analysis reveals that the child's cells lack one B4 chromosome and that one D_1 chromosome was replaced by the B/D translocation chromosome. Although autoradiography was of great value in permitting more precise identification of the sex chromosomes as well as the autosomes, the technique requires great care to avoid possible pitfalls. These include high background counts, often due to light leaking into a darkroom; contamination of darkroom or equipment with radioactive material; and outdated or improperly stored stripping film or liquid emulsion. Some stains produce chemical precipitation of metallic silver and cannot be used before the autoradiographic procedure. An unusually long G_2 period sometimes results in the findings of many labeled intact cells but no labeled metaphases. The value of the information to be gained from the techniques, however, outweighs these restrictions. (auth)

11974 (CONF-671111-, pp 695-715) AUTORADIOGRAPHIC STUDIES IN CHRONIC MYELOCYTIC LEUKEMIA. Goh, Kong-Oo (Oak Ridge Associated Universities, Inc., Tenn.).

The results of the cytogenetic studies in chronic myelocytic leukemia indicated that there was an abnormal chromosome (Ph^1) associated in some way with the disease; the Ph^1 chromosome was present in the precursor cells that give rise to the myeloid, erythroid, and possibly megakaryocytic cells and was not present in the lymphocytes; occasionally it was possible to find a Ph^1 chromosome in a patient with other myeloproliferative disorders; the Ph^1 chromosome was a result of a deletion of the long arm of one of the normal G chromosomes; and a fragment, a smaller Y, and a partial deletion of a G chromosome with the deleted part being translocated to a normal D producing a translocated D chromosome with a balance in genetic material may erroneously be called a Ph^1 chromosome. (auth)

11975 (COO-119-237) RESEARCH IN RADIOBIOLOGY. Annual Report of Work in Progress in the Internal Irradiation

Program. Dougherty, Thomas F. (Utah Univ., Salt Lake City. Radiobiology Div.). Mar. 31, 1968. Contract AT(11-1)-119. 168p. Dep. CFSTI.

Separate abstracts were prepared on 11 papers in this report. A list is included of 7 publications during the period covered. (CO)

For abstracts of individual sections see: 11431, 11976–11982, 12062, 12193, and 12194.

11976 (COO–119-237, pp 7-83) INJECTION TABLES. (Utah Univ., Salt Lake City. Radiobiology Div.).

Tables representing studies of the toxic effects and special tests following the administration of a designated dose of a radionuclide by single I. V. injection in dogs are presented. Included are data for each animal, on age, weight, quantity and date of injection, days since injection or date of death, and findings in dead dogs. Separate sections of the tables cover each of the following radioisotopes: ^{239}Pu, ^{226}Ra, ^{228}Ra, ^{90}Sr, and ^{228}Th. (CO)

11977 (COO–119-237, pp 101-9) DISTRIBUTION OF ^{90}Sr IN THE HUMERUS AND THIRD LUMBAR VERTEBRA OF THE BEAGLE PUP AFTER SINGLE AND MULTIPLE INJECTIONS. Atherton, D. R.; Jee, W. S. S.; Stover, Betsy J. (Utah Univ., Salt Lake City. Radiobiology Div.).

Shortly after intravenous injection of 87 or 148 μCi ^{90}Sr/kg the ^{90}Sr/Ca ratio in the region of the proximal epiphyseal line was five to six times that of the mid-diaphysis. Later the highest ratio was found in the proximal metaphyseal region. Shortly after 10 weekly subcutaneous injections of 1 μCi ^{90}Sr the ^{90}Sr/Ca ratio was about the same in the third lumbar vertebra and in the humerus, except in the mid-diaphysis in which it was lower. The ratio then decreases more rapidly in the growing ends of the bone than in the shaft. (auth)

11978 (COO–119-237, pp 117-23) DISTRIBUTION OF ^{241}Am IN THE BEAGLE. Atherton, David R.; Lloyd, R. D.; Taylor, G. N.; Stover, B. J.; Mays, C. W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Measurement of the amounts and concentrations of ^{241}Am in a variety of tissues of the beagle was made at 1, 22, 401, and 449 days after the intravenous injection of 4.53, 2.78, 2.78, and 2.83 μCi/kg, respectively. Animals surviving 400 or more days died of extreme liver degeneration. Retention measurements were done serially on these and four animals receiving 0.897, 0.911, 0.305, and 0.310 μCi ^{241}Am/kg. The measurements are continuing on the latter four dogs. The americium concentration was measured in over 25 tissues in each of the four animals. The concentration was higher in the liver than in the skeleton. In addition, the concentration was greater in the thyroid than in the skeleton in three of the four animals studied. Whole-body measurements suggested that part of the ^{241}Am lost from the liver was redeposited in the skeleton while measurements of liver biopsies taken serially on one of the dogs showed, at most, a slight decrease in ^{241}Am concentration in that tissue. (auth)

11979 (COO–119-237, pp 124-32) MICROSCOPIC DISTRIBUTION OF ^{241}Am IN THE BEAGLE THYROID GLAND. Taylor, G. N.; Jee, W. S. S.; Dockum, N.; Hromyk, E. (Utah Univ., Salt Lake City. Radiobiology Div.).

Americium-241 deposition in the beagle thyroid gland occurred principally in the interfollicular areas. Lesser amounts were also retained in the tunica media and intima of some of the arterioles. Retention in the follicular epithelium, the colloid, and the collagenous structures such as the capsule and interlobular septa was low. There was no significant change in this general distribution pattern over a period of 448 days. (auth)

11980 (COO–119-237, pp 133-4) SOME OBSERVATIONS ON THE DEPOSITION OF ^{241}Am IN THE THYROID GLAND. Stevens, W.; Stover, B. J.; Bruenger, F. W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Twenty-two days after injection of 2.78 μCi/kg of ^{241}Am into a dog, the thyroid was removed. The tissues were differentially centrifuged and measured for radioactivity. The major activity was found in the connective tissue residue. The activity in the mitochondrial, microsomal, and supernatant fractions was not significant compared with that in the connective tissue. It is suggested that the explanation for these results concerns binding by anionic groups of the mucopolysaccharides of the ground substances. (CO)

11981 (COO–119-237, pp 135-52) ^{241}Am IN THE BLOOD: IN VIVO AND IN VITRO OBSERVATIONS. Bruenger, F. W.; Stevens, W.; Stover, B. J. (Utah Univ., Salt Lake City. Radiobiology Div.).

After ^{241}Am III was given intravenously to the beagle, the concentration in blood decreased at a rate similar to those of divalent alkaline earths. Very little ^{241}Am was found in the association with blood cells. No binding of ^{241}Am with plasma proteins could be demonstrated in samples obtained 30 minutes after injection. Complexes of ^{241}Am with both transferrin and albumin were obtained in vitro using normal and abnormal human blood. They were sufficiently stable to be isolated in low yield by gel filtration plus ion exchange chromatography. Further studies with dogs indicated that these complexes were formed in vivo very soon after injection. (auth)

11982 (COO–119-237, pp 153-7) NOTE ON THE EXCHANGE OF ^{239}PuIV BETWEEN TRANSFERRIN AND FERRITIN IN VITRO. Bruenger, F. W.; Stover, Betsy J.; Stevens, W.; Atherton, David R. (Utah Univ., Salt Lake City. Radiobiology Div.).

The transfer of ^{239}Pu IV from transferrin, which is the transport protein for iron, to ferritin, which is a storage protein for iron, was investigated by gel filtration and gel electrophoresis. The results showed that the reaction: PuIV-transferrin + ferritin → transferrin + PuIV-ferritin, occurred in vitro at pH 8, and that under the specific conditions of this experiment the ferritin complex was more stable than the transferrin complex. (auth)

11983 (COO–1429-4) A STUDY OF RADIATION ON THE BIOLOGY AND POPULATION DYNAMICS OF THE CEREAL LEAF BEETLE, OULEMA MELANOPA (L). Progress Report, September 1, 1967–August 31, 1968. Myser, Willard C. (Ohio State Univ. Research Foundation, Columbus). Sept. 11, 1968. Contract AT(11-1)-1429. 12p. Dep. CFSTI.

Experiments were conducted on the effects of radiation on survival of eggs of the cereal leaf beetle; results are shown by means of a dose-response curve. A table is presented to show effects of radiation on the number of larvae developing from eggs and percent hatch of eggs. Techniques for identifying and quantifying free amino acids in the hemolymph of irradiated larvae of the wax moth (Galleria mellonella) were refined. Results of free amino acid analyses of the hemolymph are shown by means of graphs. Five of the known amino acids from the hemolymph of irradiated larvae showed an increase over those from hemolymph of the control group, while eleven of the known amino acids showed a decrease. (H.L.W.)

11984 (COO–1744-1) A LITERATURE REVIEW OF ^{65}Zn IN BIRDS WITH SPECIAL REFERENCE TO THE MALLARD. Curnow, Richard D. (Colorado Cooperative Wildlife Research Unit, Fort Collins). June 1968. Contract AT(11-1)-1744. 15p. Dep. CFSTI.

A review of the literature on metabolism of ^{65}Zn in birds is presented. Studies on mallard ducks utilizing the Columbia River Basin revealed that these birds are important vectors in transporting ^{65}Zn. Effluent coolant waters from nuclear reactors represent the source of ^{65}Zn which accumulates in natural water systems, aquatic and terrestrial plants and animals, and man. Factors influencing zinc metabolism in domestic fowl are discussed. It was shown that protein containing phytic acid is a much less effective source of zinc than is protein containing no phytic acid. Other factors influencing zinc metabolism are dietary calcium, zinc, chelating agents, and vitamin D. Birds with low dietary zinc intakes retain radioactive and stable zinc more tenaciously than those ingesting adequate zinc diets. Excess dietary zinc appears to reduce retention. Bone is reported as the only storage tissue for zinc. During low zinc intake, zinc concentrations in bone drop while other tissue concentrations appear to remain constant. The significance of zinc-containing enzymes in metabolism is discussed. It was shown that loss of ^{65}Zn by way of egg production was influenced by dietary zinc. Affinities of various tissues for ^{65}Zn are discussed. Studies on ^{65}Zn in the food web are discussed. Low-level radioactivity in migratory waterfowl stimulated investigation into uses of ^{65}Zn as a tracer in waterfowl migrations. (H.L.W.)

11985 (COO–1601-13) COMPREHENSIVE REPORT [ON MOBILIZATION OF RADIOACTIVE EMITTERS FROM BONE], 1966–1968. [Ray, Robert D.] (Illinois Univ., Chicago). Dec. 15, 1968. Contract AT(11-1)-1601. 17p. Dep. CFSTI.

Factors affecting the uptake and metabolism of bone-seeking radioisotopes (^{47}Ca or ^{85}Sr) were studied. Results are reported from studies of mechanisms involved in the uptake of the radioisotopes by dead and living bones and the influence of total skeletal mass and of the rate of bone turnover on the rate of uptake of ^{47}Ca and ^{85}Sr in dogs. Tracer studies of bone metabolism and bone biopsies from patients with metabolic disorders of bone were compared. The effects of blood circulation, oxygen tension, vitamin D, low phosphorus diet, a diuretic drug, and parathormone on the secretion of ^{85}Sr by the bones were studied in rats. A combination of a low phosphorus diet and administration of a drug resulted in a 70% reduction of the ^{85}Sr body burden in the first week as compared to that of controls on a standard diet. (C.H.)

11986 (FOA-4-4378) STUDIES ON PLANT ACCUMULATION OF FISSION PRODUCTS UNDER SWEDISH CONDITIONS. IX. PLANT UPTAKE OF ^{90}Sr AND ^{45}Ca AS INFLUENCED BY SOIL CHEMICAL PROPERTIES. Fredriksson, L.; Haak, E.; Eriksson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Dec. 1968. 30p. Dep.

The influence of different soil factors on the uptake of ^{90}Sr and ^{45}Ca by red clover was studied in pot experiments with 169 soils. With the aid of multiple regression analysis, functional relationships between the factors studied were established. The relationships found may be used for quantitative assessments of plant absorption of ^{90}Sr through uptake under various soil conditions. (auth)(Sweden)

11987 (SZS-11/68) EXCRETION OF DEOXYCYTIDINE AND METHYLDEOXYCYTIDINE IN THE URINE OF RATS AFTER RADIOCERIUM INCORPORATION. METABOLISM OF RADIOPROMETHIUM IN MICE AFTER THE INHALATION OF ^{147}Pm CONTAINING LUMINOUS MASS. MICRODISTRIBUTION OF RADIOPROMETHIUM IN THE ORGANISM AFTER THE INHALATION OF ^{147}Pm CONTAINING LUMINOUS MASS. RADIATION DOSES IN THE LUNG DUE TO THE MICRODISTRIBUTION OF INHALED COMPOUNDS CONTAINING ^{147}Pm. Solle, M.; Gensicke, F.; Nitschke, H.-W.; Hoelzer, F.; Kraus, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). July 1968. 44p. Dep.

Separate abstracts were prepared for the four papers included in this translation. (C.H.)

For abstracts of individual papers see: 11988–11991.

11988 (SZS-11/68, pp 1-10) THE EXCRETION OF DEOXYCYTIDINE AND METHYLDEOXYCYTIDINE IN THE URINE OF RATS AFTER RADIOCERIUM INCORPORATION. Solle, M.; Gensicke, F. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (CONF-670975-4).

From 5th Annual Meeting of the European Society for Radiation Biology, Bedrichov, Czechoslovakia.

A statistically significant short-time increase in the excretion of deoxycytidine and methyldeoxycytidine was demonstrated after the intravenous injection of more than 30 μCi of ^{144}Ce per rat. Whereas after application of up to 150 μCi of ^{144}Ce per rat the excretion of both metabolites was back to normal after a few days. This increase was followed by a longer period of subnormal values in case of higher doses. (auth)

11989 (SZS-11/68, pp 12-19) THE METABOLISM OF RADIOPROMETHIUM IN MICE AFTER THE INHALATION OF ^{147}Pm CONTAINING LUMINOUS MASS. Gensicke, F.; Nitschke, H.-W. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (CONF-670975-1).

From 5th Annual Meeting of the European Society for Radiation Biology, Bedrichov, Czechoslovakia.

In comparison with ^{147}Pm-chloride particles, inhaled luminous paints containing ^{147}Pm were eliminated very slowly from the lungs of mice. Whereas during the first hrs after the inhalation the difference was not significant, the retention of the luminous paints was 50% higher between 24 hrs and 30 days. The radionuclide was accumulated mainly in the liver and the skeleton. (auth)

11990 (SZS-11/68, pp 21-9) MICRODISTRIBUTION OF RADIOPROMETHIUM IN THE ORGANISM AFTER THE INHALATION OF ^{147}Pm-CONTAINING LUMINOUS MASS. Hoelzer, F.; Gensicke, F. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (CONF-670975-2).

From 5th Annual Meeting of the European Society for Radiation Biology, Bedrichov, Czechoslovakia.

The metabolism of luminous paints containing ^{147}Pm was studied in mice. The microdistribution of ^{147}Pm in the lungs was investigated autoradiographically. The deposition of the activity in the lung is as well homogeneous as inhomogeneous in form of local concentrations that show temporal changes. Thirty days after inhalation, only local concentrations of the activity were recorded. In comparison with ^{147}Pm-chloride particles the pulmonary clearance of the luminous paints was remarkably slower. For a long time after inhalation of luminous paints the peripheral lung parts received a high radiation dose. (auth)

11991 (SZS-11/68, pp 31-42) RADIATION DOSES IN THE LUNG DUE TO THE MICRODISTRIBUTION OF INHALED COMPOUNDS CONTAINING ^{147}Pm. Kraus, W.; Gensicke, F. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). (CONF-670975-3).

From 5th Annual Meeting of the European Society for Radiation Biology, Bedrichov, Czechoslovakia.

A quantitative autoradiographic method was used to determine the activities of local concentrations of inhaled compounds containing ^{147}Pm in the lung of mice. The radiation doses to macrophages and epithelium cells in the alveoli of the peripheral lung parts were calculated. Some consequences of these radiation doses are discussed. (auth)

11992 (NYO-910-75) BIOLOGICAL EFFECTS OF RADIATION, AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. Summary Progress Report, March 15, 1965–September 30, 1968. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-910. 183p. Dep. CFSTI.

Separate abstracts were prepared on six sections of this report. A list is included of 766 publications during the period from 1950 to 1968. (C.H.)

For abstracts of individual sections see: 11993, 11994, 12066, and 12147–12149.

11993 (NYO-910-75, pp 26-31) CELLULAR RADIATION MECHANISM STUDIES. Laughlin, John S.; Kim, Jae Ho; Djordjevic, Bozidar (Sloan-Kettering Inst. for Cancer Research, New York).

The role of early and late synthesized RNA and protein in initiation of DNA synthesis was investigated in synchronized HeLa cell cultures with appropriate metabolic inhibitors. Double labeling with ^{14}C and ^{3}H-thymidine and double layer autoradiography were used. The effects of 2000 rads of x radiation on the metabolism of RNA and protein were studied in cultured cells. Fluctuations in the toxicity of several metabolic inhibitors (5-bromodeoxyuridine, hydroxyurea, phlomycin, mitomycin C, actinomycin D, daunomycin, deoxyadenosine, arabinofuranosylcytosine, excess thymidine, and puromycinaminonucleoside) during the division cycle were studied in normal and x-irradiated HeLa cell cultures. It was found that inhibition of DNA synthesis increased the survival of x-irradiated cells, particularly those in the S phase. The RBE of high-energy electrons as a function of depth in tissue-equivalent material was investigated in irradiated HeLa cells and the effects of oxygen concentration on the sensitivity of HeLa cells to 250 Kv x rays and pulsed electrons was studied using cell survival as the criterion. (C.H.)

11994 (NYO-910-75, pp 37-46) FREE RADICAL PRODUCTION IN BIOLOGICALLY SIGNIFICANT COMPOUNDS. Laughlin, John S.; Pullman, Ira (Sloan-Kettering Inst. for Cancer Research, New York).

Electron spin resonance spectroscopy was used to study reactions of free radicals formed by the reaction of high-intensity uv and x radiations with biological materials. Results are reported from ESR studies of spin transfer in x-irradiated nucleic acid-cysteamine systems; ESR studies of free radicals in x-irradiated bone; ESR studies of free radicals formed in uv-irradiated xanthine; and the possible relation of the magnetic resonance spectra of free radicals of the negative ions of certain hydrocarbons to their carcinogenic effect. (C.H.)

11995 (ORO-2832-74) RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS. Progress Report, October 12, 1967–October 11, 1968. Shalek, Robert J. (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). Oct. 14, 1968. Contract AT(40-1)-2832. 24p. Dep. CFSTI.

Following irradiation of chromosomes from cultured hamster cells, studies on their structure were conducted using electron microscopy. Techniques for high resolution stereo microscopy are described. Studies were conducted on ultracentrifugal characterization of double stranded DNA isolated from normal and x-irradiated metaphase chromosomes. Studies on the effects of low energy electron beams on mammalian cells indicated that the major radiosensitive structure was a thin peripheral shell close to the nuclear membrane in the interphase cells and a considerably thicker peripheral shell in metaphase cells. Similar studies on other types of cells showed that the major radiosensitive region was in the form of a thin shell located directly below the bacteriophage, spore and bacterial surfaces, or close to the nuclear surface of yeast cells. Studies were conducted on absorption of 20 eV to 50,000 eV electron beams in air and plastic and angular scattering of 0.5 to 80 keV electrons by collodion foils. Radiation studies of reconstituted nucleohistones included purification and fractionation of DNA, physical characterization of DNA, and selective reconstitution of DNA with pure fractions of calf thymus histones. Initial radiation events in dilute solutions of lysozyme were studied using enzymatic analysis and pulse radiolysis. Effects of γ radiation on DNA of T2 bacteriophage when irradiated within the Escherichia coli host were studied. (H.L.W.)

11996 (ORO-3329-4) THE EFFECT OF RADIATION ON MUCOSAL PHOSPHOLIPASE ACTIVITY. Progress Report. (Duke Univ. Durham, N. C. Dept. of Physiology and Pharmacology). Oct. 1968. Contract AT(40-1)-3329. 37p. Dep. CFSTI.

Studies on the effects of radiation on mucosal phospholipase activity are reported. Results of biochemical and histochemical studies on rats support the conclusion that a direct relation between phospholipase B activity and content of eosinophilic leukocytes exists in the bone marrow, peritoneal fluid, spleen, and uterus. (C.H.)

11997 (ORO-3630-4) RADIOBIOLOGY OF RNA AND DNA BACTERIOPHAGES: PHOTOREACTIVATION. Werbin, Harold (Southwest Center for Advanced Studies, Dallas, Tex.). Jan. 2, 1969. Contract AT(40-1)-3630. 31p. Dep. CFSTI.

Ultraviolet-irradiated DNA and photoreactivating (PhR) enzyme solutions were mixed and studies were conducted on distribution of DNA-photoreactivating activity in pinto bean (Phaseolus vulgaria) sprouts. Results showed that activity was present in extracts of cotyledons, plumules, hypocotyls, but not of radicles of sprouts. Graphs are presented to show effects of uv radiation on the number of streptomycin transformants in extracts of beam sprouts and effects on photoreactivity of enzymes in mixtures containing varying protein concentrations. Other experiments were conducted on the effects of pH and temperature on the activity of photoreactivating enzymes. Results of the studies indicated that the DNA–PhR enzyme is a factor responsible for photorecovery phenomena observed in higher plants. A suspension of the snow alga, Chromulina chionophila, was centrifuged and photoreactivation assays were performed on the supernatant and cell washings. Results showed that the photoreactivating enzyme was present in the supernatant and that the activity was higher at 37°C than at 0°C. Similar experiments with the thermophilic alga, Anacystis nidulans, showed that the specific activity of the photoreactivating enzyme was much higher than that of Plectonema boryanum. PhR activity in the extract was undiminished while it was stored at 5°C for 12 days. Effects of uv radiation on survival of the virus LPP-1 in the blue green alga, Plectonema boryanum, were studied. No difference was found between infectivity of irradiated LPP-1 on irradiated or unirradiated algae. There was no evidence for dark repair mechanisms in Plectonema boryanum. (H.L.W.)

11998 (ORO-3646-4) A COMPARATIVE STUDY OF RADIATION, CHEMICAL, AND AGING EFFECTS ON VIRAL TRANSFORMATION IN VITRO. Annual Progress Report, December 16, 1967–December 15, 1968. Coggin, Joseph H. Jr. (Tennessee Univ., Knoxville. Dept. of Microbiology). Contract AT(40-1)-3646. 12p. Dep. CFSTI.

Progress is reported on investigations of basic mechanisms that result in the conversion of normal hamster cells to neoplastic cells following infection with SV40 virus in an in vitro tissue culture system. Data are presented on the effects of doses of x radiation ranging from 100 to 2000 R and virus concentration on the efficiency of SV40 transformation and the correlation of exposure to x radiation with chromosome damage and SV40 transformation. (C.H.)

11999 (TID-24829) BIOCHEMICAL STUDIES ON THE OCULAR LENS IN RELATION TO CATARACTOGENESIS. Progress Report No. 57, January 1968–June 1968. Kinsey, V. Everett (Wayne State Univ., Detroit, Mich. Kresge Eye Inst.). June 1968. 27p. Dep. CFSTI.

Progress is reported on studies on mechanisms involved in the induction of lens opacities by ionizing radiation. Data are presented from radioisotope tracer studies on the effects of electrochemical potential and pH on the transport of thallium, amino isobutyric acid, taurine, and amino acids in cultured lenses. A list is included of 12 publications during the period covered by this report. (C.H.)

12000 (TT-67-56003/5, pp 710-20) STUDIES ON THE MECHANISM OF BINDING OF RADIOACTIVE CHROMIUM (^{51}Cr) BY PROTEINS. II. BINDING OF RADIOACTIVE CHROMIUM (^{51}Cr) BY FREE AMINO ACIDS. Kapuscinski, Andrzej. Translated from Polski Przegl. Radiol. Med. Nukl., 31: No. 5(1967).

The reactions of $Na_2{}^{51}CrO_4$ and $^{51}CrCl_3$ with all the amino acids present in the molecule of human hemoglobin are described. The study was carried out by the method of ionophoresis, with quantitative evaluation of some of the chemical phenomena by radiochromatography. (auth)

12001 (UCD-472-115, pp 17-18) ^{90}Sr/Ca RATIO AND CALCIUM AND PHOSPHORUS CONTENT OF BEAGLE DIET. Della Rosa, R. J.; Gielow, Fiorella; Nix, Nancy; Abrahams, C. D.; Santos, Adeline; Wittmier, J. P.

The ^{90}Sr/Ca ratio and the Ca and P concentrations in six dietary dose levels have been maintained to within 10% of prescribed values for the past 7 yr. The constancy of the dietary Ca (1%) and P (0.7%) was satisfactorily maintained by the selection of natural feed products. (auth)

12002 (UCD-472-115, pp 19-20) RETENTION OF ^{90}Sr BODY BURDENS ACQUIRED VIA GESTATION AND NURSING. Della Rosa, R. J.; Goldman, Marvin; Gilman, L. W.

The retention of ^{90}Sr body burdens acquired via gestation and nursing was compared with that of dogs exposed for 18 months through diet (main study). It was expressed by fitting the data to two exponentials which indicate an effective half-life of ~60 days for the fast component and ~450 days for the slow component. (auth) (C.O.)

12003 (UCD-472-115, pp 25-30) SERUM CHEMISTRY VALUES IN BEAGLES TREATED WITH ^{90}Sr AND ^{226}Ra. McKelvie, D. H.; Munn, Susan; Bentley, Susan.

Serum chemistry values were obtained for Beagles labeled with ^{226}Ra between 14 and 18 months of age and those uniformly labeled with ^{90}Sr from 3 weeks in utero to 18 months of age. No changes from control values were noted in the ^{90}Sr labeled dogs up to 44 months of age. ^{226}Ra dogs showed significant increases in phosphorus, (blood urea nitrogen), amylase, and transaminase values to 44 months of age. (auth)

12004 (UCD-472-115, pp 45-7) BIOCHEMICAL STUDIES ON BONE AND OTHER CONNECTIVE TISSUES. 1. BIOCHEMICAL SURVEY OF THE ORGANIC MATRIX OF BONE AND CARTILAGE. Tsai, Huan-Chang C.; Della Rosa, R. J.; Nix, Nancy.

Collagen, neutral sugars, and mucopolysaccharides were determined in rib, costal, and articular cartilage of ^{90}Sr- and ^{226}Ra-treated dogs. Hexosamines and hexuronic acid levels were markedly reduced in the cartilage of ^{226}Ra-treated dogs; this effect appeared to be dose-related. A slight decrease in the neutral sugars was also observed. No such changes were seen in rib bone. Only preliminary data are available from ^{90}Sr-treated dogs. (auth)

12005 (UCD-472-115, pp 48-9) BIOCHEMICAL STUDIES ON BONE AND OTHER CONNECTIVE TISSUES. 2. EFFECT OF ^{226}Ra ON THE MUCOPOLYSACCHARIDES OF CARTILAGE. Tsai, Huan-Chang C.; Della Rosa, R. J.; Nix, Nancy.

The hexosamines of cartilage were fractionated into galactosamine and glucosamine. An increase in glucosamine and a decrease in galactosamine content was observed in the highest-level radium-treated dogs. (auth)

12006 (UCD-472-115, pp 57-9) BONE DENSITY EVALUATIONS BY MICRORADIOGRAPH SCANNING. McKelvie, D. H.; Coffelt, Shirley.

Density variations in 80 μ bone samples were estimated by microspectrophotometric scanning of microradiographs. The technique was facilitated by use of aluminum foil step wedges as density controls for microradiographs of the bone sections. (auth)

12007 (UCD-472-115, pp 75-7) EFFECTS OF X IRRADIATION ON NUCLEIC ACID METABOLISM OF BEAGLE LYMPHOCYTES IN CULTURE. Goldman, M.; Wolf, K. K.; Klein, A. Kimi; Foin, Angela T.

Phytohemagglutinin-stimulated beagle blood lymphocytes begin transformation toward blastoid forms within 24 hr in vitro and proceed with a doubling time of about 12 hr. Initial x irradiation (300 R) reduces the cell number to about half, but does not change the transformation rate. Labeled thymidine and uridine uptake rates are similar with respect to time and x ray effect. After exposures to 0, 30, 50, 100, 300, or 500 R, uridine uptake was depressed about 50% per 100 R; cell survival and thymidine uptake were minimally affected at doses less than 100 R. (auth)

12008 (UCD-472-115, pp 78-82) INFLUENCE OF BIOCHEMICAL PARAMETERS ON METABOLIC RESPONSES OF CELLS IN CULTURE. Huff, Sally D.; Klein, A. Kimi; Foin, Angela; Goldman, Marvin.

Nucleic acid synthesis by beagle lymphocytes was measured to determine the effects of changing substrate concentration, cell concentration, and other components of the incubation medium. Maximum cellular uptake of H-3-thymidine was obtained with an exogenous thymidine concentration of 6 μM; maximum C-14-uridine incorporation occurred at 25 μM. Isolation of tritiated cellular products after incubation of intact cells with H-3-thymidine indicated that the major portion of intracellular tritium is bound to DNA. Comparison of metabolism of H-3-thymidine by cell-free preparations shows that all enzymatic steps involved in the incorporation of thymidine into DNA are decreased by 300 R x irradiation, but suggests that DNA synthesis may be reduced to a greater extent than is the phosphorylation of thymidine, which precedes its incorporation into nucleic acid. (auth)

12009 (UCD-472-115, pp 85-6) SOME RADIO- AND THERMOLUMINESCENT PROPERTIES OF TISSUES. Goldman, Marvin; Beckman, Edwina; Stone, J. M.

Preliminary measurements on thermal ash derived from normal and neoplastic soft tissues show an induced radioluminescence following x ray spectrometric analysis. Radioluminescence and thermoluminescence decay slowly following irradiation. Neoplastic tissue is characterized by high Ca and Br concentrations without decay of the thermoluminescence and, in some cases, quantitative retention of Br following thermal ashing. (auth)

12010 (UCD-472-115, pp 92-6) RADIOIODINE METABOLISM IN THE ADULT BEAGLE. Wilson, Ove; Stone, J. M.; Monty, D. E.; Bustad, L. K.

In a radioiodine metabolism study of 21 adult beagles, the thyroid accumulation and disappearance rates of ^{125}I were measured for 3 to 5 months. Maximum thyroid uptake occurred 48 to 72 hr after administration of the single dose and ranged from 9 to 25% of the dose. Maximum $PB^{125}I$ values occurred 2 to 3 days after dosing, ranging from 0.27 to 1.9% of the administered dose/liter of plasma. A mean stable PBI of 3.8 μg/100 ml was found. The biologic half-time of thyroidal iodine was a series of decreasing exponential functions indicating a multicompartmental model for iodine turnover in the thyroid of the dog. At least three compartmental effects were observed: a fast component giving an initial short biological half-life of about 7 days, one or more intermediate components successively increasing the biologic half-time, and a late, slow component of about 50 days. (auth)

12011 (UCD-472-115, pp 98-103) MATERNAL TRANSFER AND FETAL ABSORPTION AND RETENTION OF INJECTED RADIONUCLIDES IN DEER AND SHEEP. Della Rosa, R. J.; Nebesar, C. B.; Wolf, H. G.; Stone, J. M.; Abrahams, C. D.; Connolly, R. G.

Fetal absorption and retention of injected ^{47}Ca, ^{137}Cs, ^{85}Sr, and ^{131}I (to simulate biospheric contamination) was studied in Columbian black-tailed deer and domestic sheep. The amount of radionuclide transported across the placenta and deposited in the fetus was dependent upon the total mass of the conceptus, the physiological demands of fetus, and placental discrimination. Accumulation of radionuclide in the upper GI tract was presumably due to parotid gland salivary secretion. Only a slight accumulation of ^{137}Cs in fetal tissue was observed in contrast to maternal tissues. Notably higher concentration of ^{131}I in fetal deer thyroid gland was observed compared to maternal thyroid gland. (auth)

12012 (UCLA-34-P-124-5) ANNUAL REPORT, SEPTEMBER 1, 1967-OCTOBER 15, 1968. Zamenhof, Stephen ([California Univ., Los Angeles]). Contract AT(11-1)-34. 5p. Dep. CFSTI.

Studies on the effects of ultraviolet radiation showed that survival of the transforming principle (DNA) was higher than survival of the cell. The survival of DNA in vitro was lower than that in vivo. Tritium-labeled deoxynucleoside triphosphates were used in studies on DNA-dependent DNA polymerase in various regions of chicken brain during embryonic development. It was found that the cerebral hemispheres, optic lobes, and cerebellum manifested characteristic patterns of variation in DNA content during development. DNA synthesis was investigated in vivo using tritium-labeled thymidine incorporation. It appeared that the route of isotope administration that gave optimal labeling of the embryonic chick brain was by absorption through the chorioallantoic membrane. (H.L.W.)

12013 HISTOLOGICAL AND HISTOCHEMICAL STUDIES ON THE RADIATION INJURY INDUCED IN THE MULBERRY TREE. 1. EFFECTS OF γ-RAY ON THE DISTRIBUTION OF POLYSACCHARIDE AND PROTEIN WITHIN THE SHOOT APEX. Hazama, Kazuo; Katagiri, Koitsu. Nippon Sanshigaku Zasshi, 36: 477-84(Dec. 1967). (In Japanese).

Histological studies on the shoot apex irradiated with different kinds of radiation were undertaken in order to clarify the mechanism of radiation injury and the appearance of chimeric structure in X_1 plants. It was previously reported in the mulberry tree that the outer cytohistological zone (tunica) of the shoot apex was more sensitive than the inner one (corpus) when the apical bud was γ-irradiated. The difference in radiosensitivity observed between the two zones was assumed to be caused by the diversity of metabolic activity accompanying the organ formation. Therefore the results of observation are described on the distribution of polysaccharides and proteins within cytohistological zones of shoot apex irradiated with γ rays. Both resting and sprouting buds were γ-irradiated with 5, 10, and 15 KR and the dose rate was 5 KR/hr respectively. After irradiation, buds were kept at 30°C and sampled at intervals of two or three days. The shoot apices removed from buds were fixed with 80% ethanol and embedded in paraffin. Longitudinal sections were prepared at 10μ and stained by the Himes and Moriber method. Results are summarized as follows. In the resting buds, without irradiation, the patterns of staining for polysaccharides and proteins were identical in each cytohistological zone, but in the sprouting buds, the granules of polysaccharide were abundant in some cells of central meristem and subapical initial zones. Also, the staining for protein was found in the top and side parts of subapical initial zone. Effects of γ irradiation on the distribution of polysaccharide and protein within the shoot apex were compared in resting and sprouting buds. In the resting buds, the number of granules of polysaccharide, being formed in each cytohistological zone during the course of sprouting, was less, and the intensity of staining for protein was reduced compared with the unirradiated buds. While, in the sprouting buds, cells stained for protein could not be found within subapical initial zone, the granules of polysaccharide were detected within the same zone. (NSA of Japan) (TSS)

12014 STUDY ON HEMOLYSIS CAUSED BY ^{60}Co γ-RAYS IRRADIATION. REPORT 1. CORRELATION BETWEEN IRRADIATION DOSAGE AND THE BIOLOGICAL EFFECTS. Shimura, Nagahiro. (Nihon Univ., Japan). Nihon Univ. J. Med., 8: 311-27(Sept. 1966).

A study was made of the hemolytic phenomenon occurring after ^{60}Co γ irradiation in blood of man, rabbits, and rats. An attempt was made to estimate the degree of hemolysis by measuring the osmotic resistance of erythrocytes in hypotonic saline solution and by drawing the fragility curves based on the values obtained. The experiments were conducted in vivo and in vitro. Experiment in vivo: The erythrocytes were examined by drawing blood on the third day after external γ irradiation of the rats with doses of 100 R, 1,000 R, and 400 R. It appeared that the larger radiation doses produced more hemolysis. Experiment in vitro: Hemolysis was studied from the osmotic resistance of erythrocytes after γ irradiation of the blood of man and rabbits (drawn and kept in special containers) in doses of 5×10^3 R, 8×10^3 R, 1.0×10^4 R, and 5.0×10^4 R. In all cases, the osmotic resistance of irradiated erythrocytes decreased and hemolysis occurred; the larger the dose the more hemolysis occurred. (NSA of Japan) (TSS)

12015 INHIBITION OF CHLOROPLASTS BY UV-IRRADIATION AND HEAT-TREATMENT. Yamashita, Takashi; Butler, Warren L. (Univ. of California, San Diego, La Jolla). Plant Physiol., 43: 2037-40(Dec. 1968).

The site of inhibition in uv-irradiated and heat-treated chloroplasts was examined by using artificial electron donor compounds such as p-phenylenediamine and hydroquinone that donated electrons specifically to photosystem II. In both cases the electron donors restored the photoreduction of nicotinamide adenine dinucleotide phosphate and the restored activity was inhibited by 3-(3,4-dichlorophenyl)-1,1-dimethyl urea. The fluorescence of variable yield was eliminated by both inhibitory treatments and was partially restored by the electron donors in the heat-treated but not the uv-irradiated chloroplasts. The results suggest that the sites of inhibition of uv radiation and heat treatment are in the photosynthetic electron transport chain between water and photosystem II. (auth)

12016 CONTROL OF THE RECOVERY OF IMMUNE FUNCTIONS IN ISOGENIC RADIATION CHIMERAS. Duplan, J. F.; Monnot, P. (Institut du Radium, Parris). Compt. Rend. Soc. Biol., 162: 645-50(1968). (In French).

The study of the immune reaction of isogenic radiochimeras of mice by the Jerne technique showed that the production of cellules producing anti-mouton hemolysins was strongly affected by the origin of the restoration cells. The presence of a significant number of immunocytes in this cellular suspension permitted an early partial recovery of the immunity functions, but on the other hand it inhibited the production of immunocytes from root cells. Thus, the radiochimeras of fetal liver recover, at least in a month, quasi-normal immunity capacities, whereas the same level of regeneration is attained only at the end of 40 days in mice restored by spleen cells with and without additions of ganglion cells. (tr-auth)

12017 MODIFICATION OF THE CONCENTRATION OF THE PLASMA THIOL AND DISULPHIDE GROUPS AFTER IRRADIATION. Van Caneghem, P. (Univ., Liege). Compt. Rend. Soc. Biol., 162: 792-4(1968). (In French).

The proteinemia, free S-S + -SH, and combined S-S + -SH groups were measured in rats and guinea pigs exposed to x radiation at 500 R. In both animals the drop of the S-S + -SH groups combined with proteins was accompanied by a decrease of the rate of proteins in the blood. There was a significant degree of correlation between the values of proteinemia and corresponding S-S + -SH. The hypoproteinemia of irradiated rats was principally a hypoalbuminemia. The quantity of free S-S + -SH in the blood was small compared with that combined with proteins. The decrease of the disulfide and thiol groups in the plasma after whole-body irradiation of the rat and guinea pig corresponded to a decrease of the proteinemia. (tr-auth)

12018 IRRADIATION EFFECTS IN FRUIT AND VEGETABLES. Com. Naz. Energ. Nucl., Notiz., 14: No. 10, 100-2(Oct. 1968). (In Italian).

The effects of radiation on the chemical constituents of fruits and vegetables are discussed. Some physiological phenomena connected with the ripening of bananas are shown graphically and the stimulating and inhibiting effects of radiation on these processes are described. The effect of radiation on the ascorbic acid, thyamine, and niacin content of fruits and vegetables is also considered. (J.S.R.)

12019 EFFECT OF DIETARY PROTEIN SOURCE AND CORN OIL AND CELLULOSE LEVELS ON STRONTIUM–CALCIUM DISCRIMINATION IN GROWING RATS. Hartsook, E. W.; Cowan, R. L.; Chandler, P. T.; Whelan, J. B. (Pennsylvania State Univ., University Park). J. Nutr., 97: 95-103(Jan. 1969).

The effect of diet composition on strontium-calcium discrimination in the growing rat was investigated using tracer doses of ^{85}Sr and ^{45}Ca administered by stomach tube to both sexes in a 2 × 2 × 3 factorial experiment whose variables in addition to sex (S) were protein (P), casein or zein at a 20% dietary level, cellulose (C), at a 3 or 12% dietary level, and corn oil (CO), at a zero, 4 or 8% dietary level. Criteria of a response were the 2-hr disappearance of each isotope from the gastrointestinal tract, content of each isotope from the gastrointestinal tract, content of each isotope in the femurs and blood serum (expressed as percentage of administered dose), and the following ^{85}Sr/^{45}Ca ratios; that absorbed from the gastrointestinal tract, that contained in femurs, and that contained in blood serum. Significant main effects of treatments were: casein produced 41 and 42% greater absorption and 48 and 59% greater femur content of ^{85}Sr and ^{45}Ca, respectively, than zein, but did not alter either ^{85}Sr/^{45}Ca in femurs. Casein produced a 69% reduction of serum ^{45}Ca as compared with zein which caused the ^{85}Sr/^{45}Ca in serum to be 534% greater than the value for zein. When dietary cellulose increased from 3 to 12%, ^{85}Sr of bone and ^{45}Ca of serum were decreased by 21 and 25%, respectively. Male rats had 34 and 14% smaller quantities of femur ^{85}Sr and ^{45}Ca, respectively, than females. The main effect of dietary level of CO was nonsignificant. Significant interactions for respective criteria were: absorbed ^{45}Ca, C with CO; bone ^{85}Sr, C with CO; ^{45}Ca, C with CO; ^{85}Sr/^{45}Ca in femur, P with S and P with CO; serum ^{85}Sr, P with C; and serum ^{45}Ca, P with C and S with C. (auth)

12020 OSTEOGENIC POTENCIES OF THE IRRADIATED BONE MARROW TRANSPLANTED INTO DIFFUSION CHAMBERS. Kuralesova, A. I. (Gamaleya Inst. of Epidemiology and Microbiology, Moscow). Byull. Eksp. Biol. Med., 66: No. 11, 105-9 (Nov. 1968). (In Russian).

The bone marrow from mice which received after irradiation injections of syngenic bone marrow and from mice without such injections was transplanted into diffusion chambers. On the 5th day after irradiation the bone marrow was free from osteogenic potencies. Bone formation in the irradiated bone marrow was restored the 10th day after irradiation, and approached the normal limit on the 15th day. Osteogenic potencies of the irradiated bone marrow were correlated with the number of bone marrow cells in the femur. (auth)

12021 THE INFLUENCE OF X-RAY IRRADIATION ON THE ACTIVITY OF THE ATP-ASE IN DENERVATED AND INTACT MUSCLES. Zubenko, P. M.; Ostashkov, K. V.; Sokolov, I. I. (Dnepropetrovsk State Univ., USSR. Dnepropetrovsk Medical Inst., USSR). Byull. Eksp. Biol. Med., 66: No. 11, 31-2(Nov. 1968). (In Russian).

The activity of ATP-ase in the skeletal muscles of rabbits during irradiation was studied. A significant depression of enzymatic activity was found in the intact muscles both in the initial period, as well as during the acme of radiation sickness. In the denerated muscles radiation activity does not lead to significant changes of the ATP-ase activity. The results obtained suggest that the nervous systems plays an important role in reactions of the body to radiation activity. (auth)

12022 CERTAIN DATA ON THE FACTOR RAISING ULTRA-VIOLET FLUORESCENCE OF BONE MARROW CELLS WITH LOCAL IRRADIATION OF THE BODY. Safronova, V. G. (Central Roentgen-Radiological Inst., Leningrad). Byull. Eksp. Biol. Med., 66: No. 11, 52-5(Nov. 1968). (In Russian).

Parameters of ultra-violet fluorescence of bone marrow cells following local irradiation of the body after 4, 24 hours, 30 days and 3 months were studied. Data obtained suggest that there are two components influencing changes in ultra-violet fluorescence of bone marrow cells. Increase in the intensity of fluorescence of the myeloid tissue in screened areas of the body is apparently due to the influence of a humoral factor. It is possible that this factor retains its influence during a long period. (auth)

12023 ON THE POSSIBILITY OF PROTECTIVE SCREENING OF BONE MARROW DURING IRRADIATION OF RATS AND MICE. Shust, V. F. Byull. Eksp. Biol. Med., 66: No. 11, 55-7(Nov. 1968). (In Russian).

Hemorrhage as a stimulator of haemopoiesis in totally irradiated animals with lethal dose does not increase their life expectancy. At the same time similar stimulation of haemopoiesis when a screen is used to protect a part of the bone marrow increases the protective action of the screen. The author recorded the dependence of effect on the dimensions of the screened area of bone marrow in rats and mice. The data obtained are discussed from the point of view of the cellular theory of protective influence of screening of bone marrow during irradiation. (auth)

12024 THE EFFECT OF IONIZING RADIATION ON THE RNA SYNTHESIS IN THE NUCLEATED ERYTHROCYTES OF TADPOLES AND FROGS. Medvedev, Zh. A.; Chaban, I. A. (Inst. of Medical Radiology, Obninsk, USSR). Tsitologiya, 10: 1569-79(Dec. 1968). (In Russian).

The microautoradiography of amphibian erythrocytes incubated in vitro with ^{3}H-uridine was used for studying the effect of radiation on the nuclear RNA synthesis and the process of nuclear repression during the erythrocyte maturation. It was shown that nucleated erythrocytes of tadpoles and frogs Rana radibunda, after leaving the erythropoietic organs, continue the nuclear RNA synthesis substantially and slowly and therefore all the levels of nuclear repression can be found in blood-circulating erythroid population. The lethal irradiation of animals by high doses which strongly suppress the erythropoiesis increases significantly, with time, the proportion of inactive old erythrocytes found in peripheral blood, but does not influence very much the proportion of cells actively synthesizing RNA. The irradiation of erythrocytes in vitro before the incubation with ^{3}H-uridine and incubation of tadpole erythrocytes with thyroxine strongly decrease the number of cells capable of RNA nuclear synthesis. The origin of the small portion of erythrocytes with an active RNA synthesis in heavily irradiated animals is discussed from the point of view of reserve erythropoiesis, of fixing differentiation, and of radiation nuclear repression. (auth)

12025 EXPOSURE OF LATENT INJURIES IN THE MACROSTRUCTURE OF SERUM PROTEINS ARISING AS A RESULT OF TREATMENT WITH IONIZING RADIATION. Makarchenko, A. F.; Kirichinskii B. R.; Roitrub, B. A.; Baraboi, V. A. (Inst. of Physiology, Kiev). Dokl. Akad. Nauk SSSR, 183: 963-5(Dec. 1, 1968). (In Russian).

The changes in turbidity of albumen serum solutions irradiated by 1, 5, 10, 50, 100, 200, 400, 600, 800, and 1000 kR doses of x radiation and stored in a ultrathermostat at 56 ± 0.1° were studied. Results of the investigation showed that x radiation in the dose range from 1 to 1000 kR in the presence of an isoelectric precipitator did not affect the stability of albumin. Heating of nonirradiated solution for 30 min at 56° reduced the albumin stability very slightly. Heating of irradiated solutions caused reduced stability proportional to the dose. (R.V.J.)

12026 STUDIES OF WATER ASSIMLATION AND ^{32}P DISTRIBUTION IN VARIOUS PARTS OF CANE (PHRAGMITES COMMUNIS). Ilies, C. Celul. Hirtie, 17: 97-105(Mar. 1968). (In Rumanian).

Assimilation of mineral salts from water by the reed, Phragmites communis, was studied using a ^{32}P tracer. It was found that the mineral salts from water concentrate in the upper parts of the plant. Phosphorus concentrations in leaves were 2 to 3 times higher than in stocks or dry scale. The maximum uptake of phosphorus was found in the water roots (which carry about a 20 to 50 times higher working load than the stocks), stressing the importance of mineral supply in cane. (R.V.J.)

12027 DISTRIBUTION STUDY IN ANIMALS OF DTPA-METAL CHELATES: ^{113m}In, ^{72}Ga, ^{51}Cr. Unterspann, S.; Buraggi, G. L.; Prpic, B. (Institut fuer Nuklearmedizin, Heidelberg). Nucl.-Med., 7: 286-92(Oct. 31, 1968). (In German)

The DTPA complexes of ^{131m}In, ^{72}Ga, and ^{51}Cr have been synthetized and their distribution in the rat studied. All three complexes are eliminated by the kidney. Only ^{72}Ga-DTPA concentrated also in liver and skeleton. The distribution pattern of ^{131m}In-DTPA and ^{51}Cr-DPTA is similar. Their application in the functional and localization studies of the kidney appears to be feasible. (auth)

12028 STUDIES ON THE UPTAKE OF ^{51}Cr AND ^{64}Cu β-GLYCEROPHOSPHATE COMPLEXES BY TUMOURS. Anghileri, Leopoldo Jose (Institut fuer Nuklearmedizin, Heidelberg). Nucl.-Med., 7: 266-78(Oct. 31, 1968).

The distribution of ^{51}Cr and ^{64}Cu chlorides, acetates, and β-glycerophosphate complexes in normal and tumor-bearing rats has been studied. The β-glycerophosphates are accumulated by the tumoral tissue, but the blood radioactivity concentration of the ^{64}Cu-labeled compound is relatively high. These experimental results indicate the potential usefulness of the ^{51}Cr-β-glycerophosphate as a tumor-localizing agent. (auth)

12029 INVESTIGATIONS ON ALDOLASE ACTIVITY IN UN-IRRADIATED AND γ-IRRADIATED WHEATS. Bancher, E.; Washuettl, J. (Technische Hoschschule, Vienna). Mikrochim. Acta, No. 6, 1322-3(1968). (In German)

Comparative studies of the aldolase activity on non-irradiated and irradiated wheats showed that with increasing radiation dosage there was a decrease of the activity in the latter instance. Furthermore, an additional loss of activity appeared as a secondary effect after irradiation and storing (3 days), as shown by comparison with non-irradiated wheats. (auth)

12030 INGESTED RADON AS A SOURCE OF HUMAN RADIATION EXPOSURE. Lindell, Bo (National Inst. of Radiation Protection, Stockholm). pp 719-25 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Radon-222 is usually mentioned as a source of radiation exposure of man in connection with inhalation rather than ingestion. However, since radon is a natural contaminant of groundwater, it is of interest to study also the doses caused by intake with water. For ingestion of water containing radon, the stomach is the critical organ. The radon retention in the body is mainly determined by the transport from stomach to blood, since radon is rapidly eliminated from blood. After 4 hr only a few per cent of the ingested amount remains in the body, but is then likely to be eliminated at a lower rate, probably because of the high solubility in adipose tissues. The dose equivalent per 1 μCi radon ingested is estimated at 200 mRem, corresponding to $(MPC)_w = 10^{-4}$ μCi/ml (100 nCi/l). Concentrations of up to 5000 nCi/l have been reported in the literature. A frequent value for tap water from groundwater supplies is 1 nCi/l in many countries, while waters from deep bored wells frequently show concentrations of the order of 10 nCi/l. It is interesting to note that radon concentrations of up to 1 nCi/l have been observed in some dairy milk. (auth)

12031 THE METABOLIC AND DOSIMETRIC SIGNIFICANCE OF ^{210}Pb TO ^{226}Ra RATIOS IN THE BONE OF RADIUM DIAL PAINTERS. Petrow, Henry G. (New York Univ., N. Y.). pp 727-41 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The concentration of ^{210}Pb and ^{226}Ra was measured at 89 different sites in the skeletons of two deceased radium dial painters. Using an exponential model for both ^{210}Pb and ^{226}Ra clearance from the skeleton, the data indicate: ^{210}Pb and ^{226}Ra have equal biological half-lives. Variation in the ratios of ^{210}Pb to ^{226}Ra in individual long bones follows a distinct and reproducible pattern. The value of the ratio is lowest in the end pieces of long bones, and highest in the shaft. The ratio is high in rib and low in vertebra. These variations have been interpreted as arising from differences in the ^{222}Rn retention factors at the sites analyzed. These retention factors have been calculated, and vary from 0.20 to 0.57 compared to the skeletal average of 0.33. It is felt that the variations in the ^{222}Rn retention factors reflect fundamental differences in bone structure, namely crystal size, mineral density, and amorphous mineral content. For a ^{226}Ra burden carried 50 years, it is estimated that 5 to 6% of the average alpha dose delivered to the skeleton results from ^{210}Pb decay. The vertebra would appear to be the bone of choice to be used in estimating total body burden of ^{226}Ra. In a given dial painter, ^{226}Ra concentrations with respect to ash content, varied by a factor of 15 between the highest and lowest values. (auth)

12032 VARIATION WITH AGE OF ELEMENTAL CONCENTRATIONS IN HUMAN TISSUE. Tipton, Isabel H.; Johns, Judy C.; Boyd, Monica (Oak Ridge National Lab., Tenn.). pp 759-67 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

To determine MPC values for various segments of the population it is desirable to take into account the possible variation with age of the concentration of an element in a tissue. Studies carried out on data for 173 subjects from the United States indicate a significant ($p \leq 0.001$) correlation with age of: aluminum in lung; calcium in aorta, rib, kidney, and testis; copper in cartilage and liver; magnesium in aorta, rib and vertebra; manganese in rib; phosphorus in aorta and testis; tin in lung. Since the values for the concentrations of these elements are found to be distributed log-normally (except those for calcium in rib which were normally distributed), equations for regression lines of the log of concentration on age (concentrations on age for calcium in rib) have been determined and lines drawn with a 95% confidence interval. The concentrations of calcium, magnesium, and manganese in bone, and copper and manganese in liver are found to decrease; and the concentrations of calcium, magnesium, and phosphorus in aorta, calcium in kidney, and aluminum and tin in lung to increase with age. (auth)

12033 CALCULATION OF SPECIFIC ACTIVITY-TIME CURVES IN RELATIVELY INACCESSIBLE COMPARTMENTS OF A THREE COMPARTMENT KINETIC STEADY STATE MODEL. Shore, Moris L.; Fred, Richard K. (Public Health Service, Rockville, Md.). pp 769-74 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

When a radioactive tracer is administered intravenously to a living organism one can follow with relative ease the specific activity-time curve of the compound in the circulation. However, it is difficult to establish the specific activity-time curve of the compound in the various tissues of the organism. The nearest approach that can be made at the present time is the measurement of activity in the total organism using whole body counting techniques, or external and possible internal scanning procedures to obtain information on the specific accumulation of the radioactive tracer in a given tissue. The present study is designed to make use of the information available in the specific activity curve obtained from the plasma in conjunction with a single specific activity value obtained from a tissue to permit the calculation of the actual specific activity-time curve of the compound in the tissue. This approach has been tested in a three compartment model which has been simulated with a digital computer. (auth)

12034 TRANSLOCATION OF ^{90}Sr FROM MATERNAL SKELETON TO PROGENY DURING GESTATION AND LACTATION. Della Rosa, R. J.; Wolf, H. G.; Goldman, M. (Univ. of California, Davis). pp 201-4 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The fractional translocation of ^{90}Sr to progeny during gestation and lactation was determined in five adult Beagles previously fed a diet containing 1.1 or 3.3 μCi ^{90}Sr/g Ca. These proven dams were fed approximately 4 to 12 μCi ^{90}Sr per day for about one year during adulthood, and after 85, 102, 150, and 286 days on non-radioactive food they were rebred. The body burdens of the dams and/or their litters were determined in vivo by monitoring of the (^{90}Sr + ^{90}Y) bremsstrahlung at the time of breeding, whelping, during nursing, and at weaning, at which time the animals were sacrificed and their body burdens radiochemically confirmed. From 10 to 30% of the maternal skeletal burden of ^{90}Sr was lost by the combined influence of gestation and lactation. The fractional loss of ^{90}Sr appeared to have been dependent primarily on litter size, but may also have been influenced by the length of time from acquisition of the body burden to breeding. At birth the ^{90}Sr content of the litters represented less than 1% of the initial maternal body burdens and increased to more than 10% at weaning. The body burdens of the litters at weaning accounted for nearly 30% of the maternal loss. These data suggest that the evaluation of possible radiation hazards to the newborn from biospheric contamination requires knowledge of the maternal contribution to the body burden of the offspring as well as that from dietary sources. (auth)

12035 MECHANISMS OF PULMONARY CLEARANCE OF INHALED PLUTONIUM DIOXIDE: AN AUTORADIOGRAPHIC STUDY AND PARTICLE SIZE ANALYSIS. Casarett, L. J.; Morrow, P. E. (Univ. of Rochester Medical Center, N. Y.). Contract W-7401-eng-49. pp 173-80 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

An autoradiographic technique is described for measuring particle size distributions of inhaled $^{239}PuO_2$ in alveoli of dogs and rats at various periods of time after exposure. Additional data are presented for the tracheo-bronchial tree of rats and lymphoid tissue of dogs. In rat alveoli, an early (6 hr) decrease in MMD is followed by a rise (2 days) and a second decrease (7 to 32 days). A similar cyclic change in CMD in dog alveoli is found with a different time sequence (1 to 406 days). The implications of these and other observations are discussed. (auth)

12036 BIOLOGICAL HALF-TIMES OF ^{137}Cs AND ^{22}Na IN DIFFERENT FISH SPECIES AND THEIR TEMPERATURE DEPENDENCE. Haesaenen, Erkki; Kolehmainen, Seppo; Miettinen, J. K. (Univ. of Helsinki). pp 401-6 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

Biological half-times of ^{137}Cs in five species of fish were determined by giving per os a precisely known dose (usually ca. 250 nCi) of ^{137}Cs in a gelatine jelly or in a tiny gelatine capsule and by whole body counting the fish, first daily, then weekly, in the Institute's mobile whole body counter. Experiments were continued for up to 6 months. Twelve experiments were carried out in the field in summer (May to October) and 16 in the laboratory, where it was possible to keep a constant temperature (from 6 to 20°C) in the aquarium. The excretion of ^{137}Cs from fish follows a two-differential equation: the fast component (usually 5 to 10% but in Salmo 25 and in Cyprinus 50% of the amount administered) has a half-time of a few days, the slow component is about one order of magnitude longer. At 15°C the long component is for perch (Perca fluviatilis) 200 days, roach (Leuciscus rutilus) from 100 days (age 11 years) to 57 days (3 years). For the rainbow trout (Salmo iridaeus) the long component varies from 20 to 80 days depending on the age of the fish. The value for young fish (1 year, 20 days at 20°C) is increased to 36 days at 7 to 8°C. Crucian carp (Cyprinus carassius) of about 5 years of age has a half-time of 55 days at 20°C, 120 days at 10°C. The biological half-times of ^{22}Na are much shorter, but the temperature dependence seems to be very similar to that of ^{137}Cs. For perch, half-times of ^{22}Na were 7 days at 20°C, 15 days at 10°C; for roach 7 days at 20°C, 11 days at 10°C; for burbot 30 days at 10°C, for the Crucian carp 10 days at 20°C, 25 days at 10°C. Knowledge of the body burden and of the biological half-time makes possible calculation of the daily intake of ^{137}Cs by fish in natural conditions. (auth)

12037 ENERGY TRANSFER BY ALPHA PARTICLES TO BIOLOGICAL ENTITIES OF VERY SMALL SIZE. Booz, J. (CCR–EURATOM, Ispra, Italy). pp 19-24 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

The energy spectrum of the energy transferred by alpha particles of ^{239}Pu and ^{210}Po to cylindrical subcellular units was studied experimentally. For this purpose a cylindrical proportional counter with tissue equivalent walls of Shonka type and with an internal diameter of 5 mm was used. The counting gas is tissue equivalent (64.4% CH_4, 32.4% CO_2 and 3.2% N_2) flowing at a rate of 3 ml/min through a vacuum-tight vessel in which the counter is built. The alpha particles that have an energy of about 5 MeV enter into the counter perpendicular to its axis through a hole 1 mm in diameter, their path length inside of the counter being constant within 1%. By using gas pressures between 1 and 500 torr the biological diameter of the counter has been varied between 70 Å and 3.5 μ of tissue. The authors discuss the resolution of the counter and present measurements of the mean number of ionization that the alpha particles produce along a track length of 50 Å. (auth)

Ecology

Refer also to abstracts 11637, 11984, 12107, 12196, and 13596–13598.

12038 (BMI–171–012) ECONOMIC AND SOCIOLOGICAL REVIEW OF THE AZUERO PENINSULA, PANAMA. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic–Pacific Interoceanic Canal. Hernandez, Alejandro (Battelle Memorial Inst., Columbus, Ohio). Dec. 1, 1967. Contract AT(26-1)-171. 22p. Dep. CFSTI.

The ecology of more than 130,000 people living in the Azuero Peninsula of Panama and those living in the Archipelago de Las Perlas has become important to the planning for construction of Route 17 of the proposed new Interoceanic Canal, since meteorological studies indicated that both locales lie downwind from proposed Route 17 and could possibly be affected by fallout of radioactive materials during the use of nuclear explosives for levelling operations. Data are presented on the age and civil status, by province, of the various segments of the population, their diets, and the economy of the region, including livestock production, fishing, farming, and industrial activities. The area discussed includes only the Azuero Peninsula, that is located about 125 miles West-Southwest of the project area and separated from it by the Gulf of Panama and the islands of the Archipelago de Las Perlas, that lie in the Eastern one-third of this body of water. (C.H.)

12039 (BNWL-SA-1868) EFFECTS OF HEATED DISCHARGES ON ANADROMOUS FISHES. Nakatani, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 36p. (CONF-680638-1). Dep. CFSTI.

From National Symposium on Thermal Pollution-Biological Effects Section, Portland, Ore.

Results are summarized from a 20-yr study on the biological effects of heated discharges on the ecology of plants and animals of the Columbia River. Emphasis was placed on the effects of elevated water temperature caused by the discharge of reactor effluents on populations of Pacific salmon, Oncorhynchus, and steelhead trout, Salmo gairdneri, because of their sensitivity to warm waters and their economic importance in commercial and sport fishing. It is pointed out that during much of the year, the temperature changes in Columbia River water caused by variation in flow, the heating of the water by solar radiation, and the effects of air currents and evaporation exceed those caused by the discharge of reactor effluents. Both salmon and steelhead trout spawn in freshwater and the progeny spend varying periods in freshwater before migrating to the sea. Most of the adult fish entering the Hanford reach are transients bound for areas upstream from Hanford. Results of laboratory and field studies on the effects of water temperature on the rate of reproduction and fish population during various stages of development are discussed. (C.H.)

12040 (BNWL-SA-2070) EFFECTS OF THERMAL LOADING: THE COLUMBIA RIVER STORY. Coutant, Charles C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 3, 1968. Contract AT(45-1)-1830. 47p. (CONF-680932-1). Dep. CFSTI.

From Symposium on Nuclear Power and Environment, Stratton Mountain, Vt.

The ecological effects of thermal discharges in rivers are discussed, with emphasis on the effects of heated discharges on food chains and the welfare of fish in the Columbia River. Results are reported from studies on the effects of water temperature on populations of chinook salmon (Oncorhynchus tsawytscha) in the Columbia River. The magnitudes of the ecological changes were related to the increment of temperature elevation, the base temperature of river water, and the specific timing and location of the temperature change. (C.H.)

12041 (CEA-Bib-130) BIBLIOGRAPHIC DISCUSSION ON THE PHYSICO-CHEMICAL BEHAVIOR AND ON THE RADIO-ECOLOGY OF COBALT IN HYDROBIOLOGICAL SYSTEMS. Bittel, Robert (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1968. 72p. (In French). (EUR-3877). Dep.

The present report forms part of the investigation relating to the behavior of radionuclides with a complex physico-chemistry, whose fate, in hydrological systems, can vary according to the combinations in which they are included. The first part is dedicated to the physico-chemical aspects of cobalt. The compounds of cobalt have been examined with a special regard to the complexes with interesting biochemical compounds, usually or accidentally present in water and soils (especially if the stability of these complexes is compatible with the ecological conditions of the environment such as pH and redox. . .). The analytical chemistry of cobalt and the preparation of solutions of reference are treated extensively. The second part is dedicated to some aspects of the behavior of cobalt in water and soils. Particular stress has been laid on the phenomena of complexation in enumerating all possible chelating agents and on the phenomena of heterogeneous exchanges. 149 references (auth)(C.O.)

12042 (COO-1804-1) MICROBIOLOGY OF THERMALLY POLLUTED ENVIRONMENTS. Technical Progress Report, May 1, 1968–April 30, 1969. Brock, Thomas D. (Indiana Univ., Indianapolis. Dept. of Microbiology). Dec. 17, 1968. 11p. Dep. CFSTI.

Studies on the microbiology of thermally polluted water are reported. Preliminary results are reported on the effects of temperature on the growth of the thermophilic bacterium Thermus aquaticus in water from thermal springs; on the growth of the bacterium Sphaerotilus natans in cold water and in water polluted by thermal effluent; and on the growth of the blue-green algae Synechococcus in waters from thermal springs. The ecology of Cyandium caldarium, a eucaryotic algae that lives only in warm acid waters, was also studied. (C.H.)

12043 (ORNL-4318) THE EFFECTS OF BIOTIC COMPLEXITY AND FAST NEUTRON RADIATION ON ^{137}Cs AND ^{60}Co KINETICS IN AQUATIC MICROCOSMS. Ragsdale, H. L.; Witherspoon, J. P.; Nelson, D. J. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 174p. Dep. CFSTI.

Thesis. Submitted by H. L. Ragsdale to Univ. of Tennessee, Knoxville.

Aquatic microcosms consisting of various combinations of physical components (soil, water, and container surface) and biological components (*Physa heterostropha*, *Najas flexilis*, and *Elodea canadensis*) were used to determine the effect of increased biotic complexity on mineral cycling parameters. The stability of mineral cycling parameters was tested by stressing selected complexity levels with sublethal and lethal doses of fast neutron radiation. One microcurie each of ^{137}Cs and ^{60}Co was added to the microcosm water component and changes in compartmental activity were determined by sacrificing replicate microcosms at fixed time intervals with subsequent radiometric analysis. The transfer rate of ^{60}Co from the water and that of ^{137}Cs to the soil increased with increased complexity, while for other compartments no such linear relationship was observed. The ^{137}Cs flux patterns for most microcosm compartments were similar among complexity levels, but the ^{60}Co flux patterns of most compartments were dependent on the complexity level. The pattern of ^{137}Cs distribution among microcosm compartments was independent of complexity and was one of flow through non-soil compartments with rapid accumulation in the soil. In contrast to ^{137}Cs patterns, the ^{60}Co pathway patterns depended on complexity level with accumulation of ^{60}Co in non-soil compartments in simpler microcosms and flow of ^{60}Co through non-soil compartments to the soil in complex microcosms. Microcosm components assumed different mineral cycling roles based on changes in cycling parameters with increased complexity. Generally, these roles were different for ^{137}Cs and ^{60}Co and among complexity levels for each radionuclide. Radiation stress affected ^{60}Co cycling but no radiation effect on ^{137}Cs cycling was observed. The radiation effect on ^{60}Co cycling was dependent on the complexity level and, in general, radiation stress decreased the cycling rate of ^{60}Co. Generalizations from this study were that: cycling parameters for different elements were dissimilar in less complex systems but converged toward similarity as complexity increased; microcosm components had one or more mineral cycling roles, some of which changed with complexity levels; increased functional complexity had the greatest effect on mineral cycling, although an increase in unifunctional species modified the mineral cycling parameters; ecosystem stability was related to the sensitivity of the biological interactions and not necessarily to the sensitivity of the organisms; and on the basis of mineral cycling parameters, the simpler microcosms were less stable than the complex ones when subjected to a moderate radiation stress (sublethal dose), but more stable than complex systems when subjected to an extreme stress (lethal dose). The value of microcosms as ecological research units is discussed. (auth) (C.O.)

12044 (PRNC-60) MARINE BIOLOGY PROGRAM PROGRESS REPORT, FY 1965. (Puerto Rico Nuclear Center, Mayaguez). Apr. 1965. Contract AT(40-1)-1833. 228p. Dep. CFSTI.

Biological productivity was measured using ^{14}C. The uptake of ^{14}C was correlated with plankton volumes, amounts of chlorophyll, phosphate, and nitrate content of the water, depth of water, distance from shore, amounts of suspended material in water, salinity, water temperature, and uptake of selected radioisotopes by phytoplankton. Determinations were made of the specific activity of ^{14}C in the total carbonate of sea water and in phytoplankton. The amounts of ^{14}C in the samples were measured by beta counting and the total carbon content determined by a gas chromatographic technique. Trace element analyses were continued in samples of marine organisms, sea water, marine sediments, river water, river sediments, and selected rock, minerals, and soils of the Anasco River Valley. Methods used were neutron activation analysis, atomic absorption spectrophotometry, flame spectrophotometry, colorimetric analysis, fluorometric analysis, x-ray emission spectrography, and x-ray diffraction analysis. In addition to the measurements of trace elements, analyses were made for carbon, hydrogen, nitrogen, lithium, potassium, calcium, strontium, and magnesium in many of the samples. Uptake experiments were conducted using ^{54}Mn, ^{51}Cr, ^{59}Fe, and ^{65}Zn with *Tripneustes esculenta* (sea urchin); ^{54}Mn, ^{51}Cr, ^{59}Fe, ^{65}Zn, ^{86}Rb, ^{42}K, and ^{137}Cs with *Sargassum lendigerum* and other algae; and ^{54}Mn, ^{51}Cr, ^{59}Fe, ^{65}Zn, and ^{182}Ta with *Acanthopleura granulate* (mollusc). Measurements of world-wide fallout in several large samples of marine sediment, algae, gorgonians, sponges, crustaceans and fishes were made. The disintegration rates of the radioisotopes were calculated on the basis of wet, dry, and ash weight. Measurements were made of ^{57}Co/^{60}Co ratios in samples and compared with the ^{57}Co/^{60}Co ratio in samples from the Pacific Ocean. Measurements of bottom contours, salinities, temperatures, turbidities, dissolved oxygen contents, and current directions and velocities were continued. Ecological studies of food web relationships were conducted. Associations under observation included algae-molluscs, algae-echinoderms, echinoderms-gorgonians, sponges-arthropods, omnivorous fishes, and mollusc-sipunculid-annelid-echinoderm-crustacean relationships to sediment compositions and sizes. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 11995, 12185, 12229, 12238, 12240, 12241, and 12246.

12045 (AEC-tr-6646/4A, pp 7-9) STUDIES ON E. COLI MUTANTS DEFECTIVE IN DNA REPAIR. Boyce, Richard; Howard-Flanders, Paul. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Escherichia coli K12 mutants defective in DNA repair can be divided into two main classes, the excision mutants and the recombination deficient mutants. Effects of methylmethane sulfonate, mitomycin C, nitrogen mustard, uv radiation, and x radiation on the two classes of mutants are summarized in the form of a table. (H.L.W.)

12046 (AEC-tr-6646/4A, pp 31) RESTORATION CONFERRED ON IRRADIATED BACTERIAL CELLS UPON COMPLETE TRANSFER OF AN IRRADIATED CHROMOSOME. Johansen, Ivar. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

In the Hfr/F$^-$ mating system of *Escherichia coli* recombinants with an integrated distal male marker appear with a frequency of about 0.1. Analyses of the genetic constitution of these recombinants reveal that slightly less than 50% of their genome originates from the donor cells. X-irradiation of the recipient cells before mating has little effect on the distribution of male and female genetic material in the recombinants. Furthermore, the frequency of recombinants decreases with increasing dose, and the dose-response curve is not markedly different from the survival curve for recipient cells. The findings suggest that a major part of the lethal x-ray induced damage to bacteria may be ascribed to effects on the bacterial chromosome. (H.L.W.)

12047 (AEC-tr-6646/4A, pp 115-19) SPONTANEOUS AND RADIATION INDUCED CHROMOSOME ABERRATIONS IN THE BONE MARROW OF RATS IN VIVO. Jankovic-Stejin, V.; Kanazir, D.; Becarevic, A. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Chromosome examinations were made on four groups of rats: normal, DNA-treated, x-irradiated, DNA-treated and x-irradiated. The bone marrow of rats treated with DNA contained a higher frequency of abnormal cells and also a higher frequency of aberrations per cell than that of normal rats. Examination of cells from bone marrow of irradiated rats revealed changes in number and arrangement of chromosomes and structural damage. The most frequent aberrations were acentric chromosomes formed by breakage in the centromere zone. All types of aberrations occurred with a frequency considerably greater than that of control animals. In irradiated animals treated with DNA the frequency of aberrations was lower. (H.L.W.)

12048 (COO-1512-11) MUTATION STUDIES INVOLVING QUANTITATIVE TRAITS. Gardner, C. O. (Nebraska Univ., Lincoln. Dept. of Agronomy). Sept. 25, 1968. Contract AT(11-1)-1512. 37p. (CONF-680824-1).

From 7th Symposium on Gamma Field, Mito, Japan.

Research on the effects of ionizing and non-ionizing radiations on quantitatively inherited traits in crop plants was initiated at the University of Nebraska in 1953. Primary objectives were to obtain basic information on the inheritance of quantitative traits, to determine the effect of mutagenic treatments on genetic variation in populations, and to assess possibilities for greater improvement in treated populations. Ultraviolet light treatment of pollen and x-ray and thermal-neutron treatment of seeds were used initially and more recently EMS treatment has been used. Corn was the primary crop studied but a number of other crops were treated and recent work involved Arabidopsis. Findings regarding population variation are reported with special emphasis on two long-term mutation breeding experiments. (auth)

12049 (NYO-3671-4) RADIATION-INDUCED CHROMOSOMAL INVERSIONS IN MOUSE POPULATIONS. Progress Report, November 1, 1967-October 30, 1968. Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). Nov. 29, 1968. Contract AT(30-1)-3671. 11p. Dep. CFSTI.

Male mice were exposed to 700 to 900 R doses of x radiation and mated immediately with females of a different strain. One testis was removed surgically from each of the male offspring when they were approximately 100 days old and meiotic sperm cells were examined for chromosome inversions by scoring the frequency of first anaphase bridges. These male mice were then mated with vigorous females to produce offspring and thus preserve the presumptive inversion. A total of 562 male offspring of irradiated sires were examined and a total of 15 presumptive inversions were observed. The frequency of chromosome inversions in the irradiated population was considerably higher than that of non-irradiated populations. Animals with the four highest frequencies of anaphase bridges were propagated and data are summarized on the frequency of anaphase bridges observed cytologically in descendents. The development of screening tests for radioinduced biochemical mutants and normally occurring isozyme polymorphism in mice is discussed. (C.H.)

12050 (ORO-3014-4) EFFECTS OF RADIATIONS ON THE GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSICAL AND BIOCHEMICAL SYSTEMS. Comprehensive and Final Report, 1965-1968. Alexander, Mary L. (Texas Univ., Austin). May 31, 1968. Contract AT(40-1)-3014. 8p. Dep. CFSTI.

Studies on the genetic effects of therapeutic x rays, with an ion density of 80 ion pairs per micron, and betatron x rays, with an ion density of only 8.5 ion pairs per micron, on germ cells of Drosophila are reported. The combined effects of ethylenimine and x radiation on the induction of mutations, the effects of dose rate on genetic damage, and the induction of mosaic lethals by ethylenimine, x radiation, and combined treatments with both mutagenic agents were also studied. (C.H.)

12051 (UCD-472-115, pp 104-5) MARMOSA MITIS, A SMALL MARSUPIAL FOR STUDIES IN RADIATION BIOLOGY. Bustad, L. K.; Wolf, H. G.; Barnes, R. D.

Marmosa mitis (also known as Marmosa robinsoni, Bangs), a small, pouchless South American marsupial, is a recommended subject for study of the effects of external x irradiation and of ^{90}Sr and other internal emitters because of its simple chromosome pattern and the accessibility of fetuses. (auth)

12052 (UCD-472-115, pp 110-12) CYTOGENETIC EFFECTS OF X IRRADIATION AND ^{90}Sr IN MARMOSA MITIS. Wolf, H. G.; Siemon, Leslie; Philbrick, A. L.; Scott, C. D.; Goldman, Marvin; Bustad, L. K.

The cytogenetic effects of x- and β-irradiation on Marmosa mitis (2N = 14) were evaluated in a pilot study. Three animals were x-irradiated (120 R) and 8 were injected i.p. with ^{90}Sr, 4 each at 0.3 μCi/g and 0.03 μCi/g body weight. Peripheral blood and bone marrow were collected periodically after exposure, and mitotic preparations were examined. Chromosome abnormalities were found in all treatment groups. Incidence of damage was higher in x-irradiated animals than in those treated with ^{90}Sr. Marrow preparations showed a higher incidence of damage than preparations from peripheral blood. (auth)

12053 DISTURBANCES OF CELL DIVISION IN BONE MARROW OF RATS IRRADIATED WITH 50 MeV PROTONS. Govorun, R. D. Kosm. Biol. Med., 2: No. 6, 21-5(Nov.-Dec. 1968). (In Russian).

The processes of cell division and depletion of bone marrow of rats exposed to whole-body irradiation with 50 MeV protons were studied. The irradiation was shown to disturb mitotic activity and division of bone marrow cells and to produce their destructive changes. The changes of the mitotic activity, amount of aberrant mitoses and cells with nuclear destructions were observed for 7 days after the exposure. The dose dependance of the number of aberrant cells and value of the mitotic index were investigated a day after irradiation. The dose linear dependance of the number of aberrant mitoses was established for the dose range of 100 to 550 rads. No significant differences between the biological effect of 50 MeV protons and ^{60}Co γ rays were detected. For the tests analyzed, the relative biological effectiveness is 1 or a little over. (auth)

12054 CYTOGENETIC TECHNIQUES IN RADIOBIOLOGICAL PROCEDURES. Barnes, C. A.; Ilbery, P. L. T. (Univ. of Sydney). Australas. Radiol., 12: 395-402(Nov. 1968).

Techniques are described for the examination of cells of cultured tissues of animals and humans for chromosome aberrations induced by exposure to ionizing radiation. The methods were used for the examination of normal and leukemic lymphocytes, bone marrow, spleen, thymus, and lymph nodes of mice and leukocytes from normal man and patients with leukemia. (C.H.)

12055 UTILIZATION OF CHROMOSOME ANALYSES IN BIOLOGICAL DOSIMETRY. Biola, M. T.; Le Go, R. (CEA, Fontenay-aux-Roses, France). pp 33-45 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Blood removed from a healthy subject was irradiated in vitro. Six samples of blood were enclosed in a phantom near an experimental critical assembly. Each sample received a different dose of mixed gamma and neutron radiation. Twenty-eight cultures of lymphocytes were made from the samples. The technique used was a micromethod derived from Edwards, Arakaki, and Sparkes. Chromosome aberrations were studied in two groups of cultures: in the first group the cultures were arrested at the end of 72 hr; in the second group they were arrested at the end of 96 hr. The relation between dose and type of aberration is discussed. These data are correlated with observations made before irradiation of blood. Observations of blood irradiated in vitro are correlated with observations of chromosome anomalies in irradiated humans. (tr-auth)

12056 CHROMOSOME ABERRATIONS OF LEUKOCYTES IN THE PERIPHERAL BLOOD OF PERSONNEL SUBJECTED TO IONIZING RADIATION. Pendic, B. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 47-51 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Chromosome aberrations observed in a group of radiologists and in personnel of the Boris Kidric Institute working with sources of ionizing radiation are reported. Radiation doses did not exceed permissible doses. Results show that chromosome aberrations are more frequent in exposed personnel than in the controls. The correlation between the observed aberrations and radiation dose is discussed as well as the clinical and prognostic importance of persistent chromosome aberrations. (tr-auth)

12057 RADIOBIOLOGICAL RESEARCH IN A CENTRAL ELECTRONUCLEAR LABORATORY ENEL. Farulla, Antonio (Univ., Sassari, Italy). pp 53-63 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In Italian).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The preliminary results of a research program directed in particular to the study of cytogenetic modifications induced by prolonged exposure to low doses of ionizing radiation were reported. The study, conducted on employees of a nuclear power plant, subdivided into groups with respect to the laboratory work and to the exposure unit, first defined the base karyogram and then experiments were made during the laboratory activity. In the present state of the investigation, a 13% aneuploidy plate with a sharp prevalence of hypomodal count over hypermodal count was observed; with respect to the chromatid anomaly, the percentage found was 6.7% of the total cells examined. In the course of successive tests significant modifications of the base karyogram were not found. Values almost analogous either to the incidence of aneuploid cells or to the frequency of chromatid anomalies were observed in large groups of subjects selected as controls with characteristics of age, sex, etc., comparable to that of the employees and previously unexposed to radiation either from professional, diagnostic, or therapeutic sources. (tr-auth)

Health Physics and Safety

Refer also to abstracts 11444, 11656, 11752, 11753, 11755, 11808, 11915, 11990, 11991, 12030, 12036, 12044, 12055, 12180, 12254, 13149, 13530, 13531, 13551, and 13555.

12058 (AE-342) REPORT ON THE PERSONNEL DOSIMETRY AT AB ATOMENERGI DURING 1967. Carlsson, J.; Wahlberg, T. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1968. 10p. Dep.

Results are presented for the personnel dosimetry at AB Atomenergi during 1967. The external total body gamma dose for all employees (quarterly doses less than or equal to 100 mrem are not reported) corresponds to 140 manrem. The highest external total body gamma dose during 1967 to one person was 5700 mrem. 24,700 gamma films and 3900 neutron films were evaluated. 1988 urine analyses and 989 measurements of body activity were made. (auth)(Swed)

12059 (AHSB(RP)R-85) PERSONNEL DOSE ASSESSMENTS FOLLOWING ACCIDENTAL NON-UNIFORM IRRADIATION OF THE BODY. Langmead, W. A.; Adams, N. (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch); Holliday, B.; Tyler, G.; Brown, James (United Kingdom Atomic Energy Authority, Dounreay (Scotland). [Reactor Group]). Sept. 1968. 49p. Dep. CFSTI. UK 7s.

An incident which involved the accidental exposure to external radiation of two men on the floor of the experimental fast reactor at Dounreay was reconstructed. The reconstruction, carried out in order to determine the radiation doses received by the two men, necessitated the filming of stages in the incident using a dummy source, the measurement of the dose-rate distribution around an irradiated fuel element and its simulation using ^{137}Cs point sources, the measurement of the dose-rate distribution around a man-phantom containing $^{137}CsCl_2$ solution, and the measurement of depth doses in a water phantom irradiated by a fuel element. These experimental measurements enabled the determination of doses to the men's eyes, gonads, hands and skin, and also the distribution of dose with depth at the waist level of one of the men. By making use of the reciprocal dose theorem, the integral doses and average doses to the bodies of the men were also determined. A short discussion of the validity of the reconstruction and the accuracy attainable is presented. (auth) (UK)

12060 (CEA-R-3583) MAXIMUM PERMISSIBLE CONCENTRATION OF ^{222}Rn IN AIR. Hamard, Jean; Beau, Paul-Georges; Ergas, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1968. 28p. (In French). Dep.

In order to verify the validity of the values proposed for the maximum permissible concentration of ^{222}Rn in air, one can either approach the problem by epidemiological studies tending to determine the dose-effect relation both quantitatively and qualitatively, or by choosing a lung model and clearance constants allowing a more accurate determination of the delivered dose and the localization of the more severely irradiated portions of the bronchial tree. The radon MPC has been calculated using the model and the respiration constants set up by the I.C.R.P. Task Group on lung dynamics. Two cases have been considered, i.e., when the radon daughter products behave as soluble materials and as insoluble ones. The values which have been found have been compared with those given up to now by several national and international bodies. (auth)

12061 (CNEA-215) COMPARATIVE DOSIMETRIC STUDY IN THE TREATMENT OF GYNECOLOGICAL CANCER WITH RADIATION. Dosoretz, B.; Feliu, A.; Mugliaroli, H. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 20p. (In Spanish). Dep.

The clinical aspects and the therapeutic regime used in the Servicio de Telecobaltoterapia for the treatment of cervical cancer were described. Dosimetry problems resulting from the application of the therapeutic regime are considered and dose distribution curves for the bladder and rectum for different geometries of the intracavity radium applicator are given. The relative doses in the rectum and bladder were analyzed in relation to the proximal side in intracavity therapy. The dose relation between proximal and distal sides was analyzed for different geometries of the intracavity applicator. The dose relations between distinct points of therapeutic interest in the treatment with external therapy were analyzed. The integral dose corresponding to distinct treatment techniques was shown. (tr-auth)

12062 (COO-119-237, pp 110-16) ^{210}Pb CONTAMINATION OF ^{228}Th: ITS CONTRIBUTION TO DOSE IN BEAGLES IN OUR ^{228}Th TOXICITY STUDIES. Atherton, David R.; Lloyd, Ray D.; Clark, David O.; Mays, Charles W. (Utah Univ., Salt Lake City. Radiobiology Div.).

Beagles injected with our first stock of ^{228}Th were virtually free of ^{210}Pb contamination, but for the second and third stocks, the injected contamination ranged from 0.08 to 0.24 μCi ^{210}Pb/μCi ^{228}Th. Preliminary studies of seven beagles intravenously injected with ^{210}Pb in citrate solution suggested that its total body retention was somewhat similar to that for ^{90}Sr, dropping to about $\frac{1}{4}$ of the injected activity at three months post injection. At 10 yrs after injection the estimated skeletal dose in rads from ^{210}Pb relative to that from ^{228}Th was 0%, 1%, and 3% for the toxicity-study dogs receiving the lowest, medium, and highest ^{210}Pb/^{228}Th ratios. Thus, the skeletal dose from the ^{210}Pb contamination in the ^{228}Th-injected dogs was negligible. However, in some of the test dogs injected with ^{224}Ra prepared from contaminated ^{228}Th stock, the ^{210}Pb accounted for the major fraction of the radiation dose. (auth)

12063 (KURRI-TR-32) RECORDS OF THE INTERIOR RADIATION CONTROL AT THE KYOTO UNIVERSITY RESEARCH REACTOR INSTITUTE IN 1966. Katurayama, Kousuke; Yoshii, Giichi; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). Feb. 1967. 23p. (In Japanese and English). Dep.

The records of the interior (indoor) radiation control, including reactor room, hot and tracer laboratories, waste disposal facility, etc., in 1966, the third year of operation of the Institute, are given in the following: radiation levels, integration doses, surface contaminations, radioactive concentrations in the drainage, canal water, dust and gas, and stack gas, integration doses along the pneumatic tubes, leak doses in the γ-ray irradiation room, differential pressure changes in blower filters. With the third year of operation, the backgrounds in the laboratories were not as high as had been expected. Radioactive concentrations in the drainage tended to be high, owing possibly to the increased amount of radioactive materials handled. (NSA of Japan)

12064 (NP-17668) ANNUAL REPORT TO THE DIRECTOR-GENERAL FOR THE YEAR ENDED 30th JUNE 1968. (Commonwealth X-Ray and Radium Lab., Melbourne (Australia)). 37p. Dep.

Radiation protection programs in Australia are reviewed. Problems arising from the use of ionizing radiation and radioactive substances in medicine, research, and industry are reviewed. Radiation dosimetry and monitoring services, the calibration of radiation sources, advisory services, the procurement and distribution of radioisotopes, and the inspection of radiation sources are discussed. (C.H.)

12065 (NP-17691) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 7. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). July 1968. 21p. Dep.

The report from the fallout monitoring program in Canada during June 1968 includes data on the total β activity in air filter samples and the content of ^{137}Cs and ^{90}Sr in samples of milk collected at selected locations. The results of analyses for radioactivity carried out on samples of surface water and biological materials collected in the vicinity of Canadian reactors are included. (C.H.)

12066 (NYO-910-75, pp 31-7) THEORETICAL STUDIES OF RADIATION ABSORPTION. Laughlin, John S.; Kessaris, Nikitas D. (Sloan-Kettering Inst. for Cancer Research, New York).

Investigations on the effects of LET on the biological effects of high-energy pulsed radiations were continued. A mathematical analysis was carried out to obtain the probability distribution of radiation dose and effective LET in a microscopic volume of tissue-equivalent material when the macroscopic quantity is delivered. The present state of knowledge on the penetration, scattering, and absorption of high-energy electron beams in biological materials is reviewed. (C.H.)

12067 (NYO-3364-46) ^{137}Cs IN PEOPLE AND FOOD IN NORWAY, 1963-1967. PART II. Stroemme, Aksel (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 45p. Dep. CFSTI.

Data are presented on the content of ^{137}Cs in human food chains in Norway during 1963 through 1967. Geographical and seasonal variations were studied, and the relation of precipitation and feeding habits of milk cattle and animals used for food to the content of ^{137}Cs in milk, beer, and meats from beef cattle, goats, and sheep are discussed. The concentrations of ^{137}Cs in the spring of 1966 were slightly higher than those recorded in 1963, but were markedly lower than those recorded during 1964 and 1965. Concentrations during 1967 were significantly lower than those during the previous four years. (C.H.)

12068 (ORO-2401-11) INHERENT PROBLEMS IN THE QUANTITATION OF ISOTOPE SCAN DATA. Johnston, R. E.; Brill, A. B. (Vanderbilt Univ., Nashville, Tenn. Div. of Nuclear Medicine and Biophysics). Mar. 1968. 20p. (CONF-680804-5; SM-108/110). Dep. CFSTI.

From Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria.

Investigations of the γ-ray spectra measured from different sized radioisotope sources at different depths in an extended scattering medium, using two types of collimated scintillation detector systems, indicated that there was information contained in the total spectrum in addition to that contained in the photopeak energy region. It was demonstrated that the photopeak to scatter ratio is a good indicator of source depth when the detector system field of view is equal to or greater than the size of the source. The extent to which small angle scattered photons contribute to the photopeak and how this must be considered in the choice of a radioisotope for scanning procedures was investigated.

It was found that when a detector system was calibrated with a source distribution in a specific phantom configuration, and then the system was used to measure unknown quantities of radioactivity in an in vivo situation with similar source and scattering configuration, the photopeak to scatter ratio provided an excellent correction factor. But, to calibrate a detector system with peak to scatter ratio as correction factors for all the wide variety of source and scattering media geometries one might possibly encounter is a formidable task. Experience with simple lucite phantom studies showed that a better approach to the problem of quantitating external measurements was to acquire a library of spectral information from point sources of known activity at different distances off axis and different depths in a scattering medium for each radioisotope and detector system. Any source configuration can then be mathematically simulated and the spectral distribution and counts per μCi computed. Comparison of the measured information to the computed information would give the actual μCi content of the source. Information on the 3-dimensional shape of the distribution volume is essential for these computations, and may be obtained using tomographic scanning systems. (C.H.)

12069 (RD/B/N-1007) SKIN DOSIMETRY PROBLEMS IN NUCLEAR OPERATIONS. Wheatley, B. M.; Harvey, J. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 16p. Dep.

Outstanding problems in skin dosimetry relevant to nuclear power are reviewed and discussed. It is shown that skin dose estimations involve professional judgement in interpreting any measurements made. Although skin dose is usually only limiting with so-called soft radiation, it is shown that it can also be limiting for small radioactive particles close to the skin and emitting hard radiation. (auth)

12070 (RISO-181) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1967. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1968. 25p. Dep.

Measurements of fallout radioactivity in the Faroes in 1967 are presented. ^{90}Sr (and ^{137}Cs in most instances) was determined in regularly collected samples of precipitation, milk, potatoes, sheep, fish, and drinking water. In addition, analyses of spot samples of grass, soil, sea water, sea plants, birds, vegetables, fodder, bread, and fresh water were carried out. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1967 are given. (auth) (Denmark)

12071 (RISO-182) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1967. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1968. 19p. Dep.

Measurements of fallout radioactivity in Greenland in 1967 are reported. Strontium-90 (and ^{137}Cs in most instances) was determined in samples of precipitation, soil, sea water, vegetation, animals, and drinking water. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1967 are given. (auth)

12072 (SWRHL-40-r) PASTURE AND GREEN CHOP FEEDING PRACTICES IN NEVADA WITHIN 300 MILES OF PAHUTE MESA IN THE 0^0-60^0 TRAJECTORY. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab. National Center for Radiological Health, Rockville, Md.). Nov. 1968. 13p. Dep. CFSTI.

Feeding practices for milk cows within a specific trajectory in the State of Nevada are presented. Graphs show that the number of cows fed on pasture increases rapidly during the month of April and decreases sharply during October. Also included is information on milk production and distribution in Nevada and Utah. (auth)

12073 (SWRHL-54-r) ANIMAL INVESTIGATION PROGRAM BASELINE STUDIES: SUPPLEMENTAL TEST SITE "C." Hull, Bruce P. Jr.; Cohen, Stanley L. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab. National Center for Radiological Health, Rockville, Md.). Sept. 13, 1968. 18p. Dep. CFSTI.

Tissue samples from two mule deer and three beef cattle from the proposed Supplemental Test Site in Nevada were collected for radioanalysis and histopathologic studies prior to the Faultless event. Pathologic lesions present and detectable body burdens of selected radioisotopes were comparable to those found in routine sacrifices. (auth)

12074 (UCRL-50163(Pt.5)) PREDICTION OF THE MAXIMUM DOSAGE TO MAN FROM THE FALLOUT OF NUCLEAR DEVICES. V. ESTIMATION OF THE MAXIMUM DOSE FROM INTERNAL EMITTERS IN AQUATIC FOOD SUPPLY. Tamplin, Arthur R.; Fisher, H. Leonard; Chapman, William H. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 10, 1968. 20p. Dep. CFSTI.

A method is described for estimating the maximum internal dose that could result from the radionuclides released to an aquatic environment. By means of this analysis one can identify the nuclides that could contribute most of the internal dose, and determine the contribution of each nuclide to the total dose. The calculations required to estimate the maximum dose to an infant's bone subsequent to the construction of a sea-level canal are presented to illustrate the overall method. The results are shown to serve the basic aims of preshot rad-safe analysis and of guidance for postshot documentation. The usefulness of the analysis in providing guidance for device design is further pointed out. (auth)

12075 (UCRL-Trans-10295) DETERMINATION OF THE MAXIMUM PERMISSIBLE RADIONUCLIDE CONCENTRATION FOR THE LUNGS. Vacca, Georges. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Translated by L. M. Chandler for Univ. of California Lawrence Radiation Lab., Livermore, from report CEA-R-3382. 64p. Dep.

A model was designed for the deposition of dust in the lungs and lymph nodes and its clearance in the blood and gastrointestinal tract. The model was used for determination of maximum permissible concentration values. The values for more than 200 radioisotopes are tabulated from data reported by the International Commission on Radiation Protection. (H.L.W.)

12076 (UWFL-91) GAMMA DOSE RATES AT RONGELAP ATOLL, 1954-1963. Held, Edward E. (Washington Univ., Seattle. Lab. of Radiation Biology). May 1965. Contract AT(45-1)-1385. 16p. Dep. CFSTI.

Rongelap Atoll, Marshall Islands, was contaminated with fallout from a thermonuclear device on March 1, 1954. Gamma-dose rates on time detonation plus one day (D + 1) ranged from 3.5 R/hr to 35 R/hr. Until 1959, the decline of γ-dose rates measured in the field followed the theoretical decay of mixed fission products from ^{235}U calculated by Miller and Loeb. The reduction of γ-dose rates to approximately half the predicted levels in 1959 to 1963 probably reflects the downward movement of the long-lived γ-emitter ^{137}Cs in the soil. Redistribution of fallout had little effect on γ-dose rates except in the intertidal zone. It is concluded that predicted γ-dose rates from fallout based on the theoretical decay curve of radionuclides from fission of ^{235}U would tend to be equal to or greater than actual levels. (auth)

12077 (ZFK-125) DEVELOPMENT OF THE TOLERANCE DOSE. Abel, Helmut; Haberer, Gudrun (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). May 1967. 16p. (In German). Dep.

The history of the development of the tolerance dose for radiation can be divided into four phases. In the first phase from 1895 to 1920 radiation injuries were described and proposals for the shielding of radiation sources were developed. In the second phase from 1920 to 1940, the emphasis was on the estimation of the radiation doses received by personnel working with radiation sources. In the third phase from 1945 to 1955 the number of professionally exposed persons increased rapidly and radiation protection research underwent an enormous expansion. The fourth phase, beginning in 1955, was characterized by the working out by expert groups under the auspices of the ICRP of a number of critical analyses and reports on various problems of radiation protection. A maximum permissible annual dose of 5 rem was established. 35 references. (J.S.R.)

12078 DETERMINATION OF MAXIMUM PERMISSIBLE DOSES AS PROTECTIVE MEASURES IN AN IONIZATION RADIATION LABORATORY. Com. Naz. Energ. Nucl., Notiz., 14: No. 10, 105-12(Oct. 1968). (In Italain).

The Italian regulations on maximum permissible doses and concentrations for laboratories using radiations and radioisotopes are presented. The maximum permissible concentrations of a radionuclide in drinking water and in the air are tabulated. (J.S.R.)

12079 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 9: 289-336(June 1968). (RHD-(Vol.9)-(No.6)).

Separate abstracts were prepared on the four sections of this report dealing with routine monitoring programs of the Public Health Service and cooperating agencies. (E.R.B.)

For abstracts of individual sections see: 12080-12083.

12080 MILK AND FOOD. Radiol. Health Data Rep., 9: 289-304(June 1968).

Data from the continuous radionuclide surveillance programs of the Pasteurized Milk Network (PMN), Canadian Milk Network (CMN), and Pan American Milk Sampling Program (PAMSP) are presented for February 1968. The PMN data include ^{90}Sr content of pasteurized milk in the United States during this period, and a summary of the ^{90}Sr content during 1964 through February 1968. The average monthly content of ^{89}Sr, ^{90}Sr, ^{137}Cs, ^{131}I, and ^{140}Ba in pasteurized milk during March 1967 through February 1968 are also presented. The CMN data include calcium, potassium, ^{137}Cs, and ^{90}Sr contents of liquid whole milk sampled in Canada for the report period. The PAMSP data include potassium, ^{137}Cs, and ^{90}Sr contents of pasteurized milk in samples from Pan American stations for the report period. State milk surveillance activities are reported for California, Oregon, and Washington. These data include radioisotope content of pasteurized milk from sampling stations collected during October to December 1967. Data are also included on the ^{90}Sr content of human diet in Chicago, New York City, and San Francisco during April to December 1967. All data are reported in graphic and tabular form. (E.R.B.)

12081 WATER. Radiol. Health Data Rep., 9: 305-11(June 1968).

The gross α and β radioactivity levels of surface waters from selected sampling sites in the United States are presented for December 1967. The gross β radioactivity in California water supplies during January to June 1967, and the ^{141}Ce, ^{144}Ce, ^{137}Cs, ^{40}K, ^{226}Ra, ^{89}Sr, ^{90}Sr, and ^{95}Zr content of California water supplies during 1966 to 1967 are recorded. The ^{90}Sr content of New York City tap water is listed for July through December 1967 and summarized for 1955 through 1967. (E.R.B.)

12082 AIR AND DEPOSITION. Radiol. Health Data Rep., 9: 312-19(June 1968).

The gross β radioactivity in surface air and precipitation during February 1968 is reported for selected sampling sites in Canada, Mexico, Pan America, and the United States. Monthly and yearly profiles of β radioactivity in air are summarized for selected cities in the United States. These summaries are for 1962 through February 1968. All data are reported in graphic and tabular form. (E.R.B.)

12083 OTHER DATA. Radiol. Health Data Rep., 9: 320-35(June 1968).

The ^{137}Cs, ^{89}Sr, and ^{90}Sr content of muscle and rumen in selected Alaskan caribou and reindeer herds is reported for August through October 1967. The average ^{137}Cs content of muscle in Alaskan caribou and reindeer is summarized by district for 1966 through 1967. The ^{90}Sr content of human bone samples from the United States is presented for samples collected during January through March 1967. Environmental radioactivity levels are presented for July through December 1967 at Atomic Energy Commission installations at Atomics International in California and Savannah River Plant in South Carolina. The Atomic Energy Commission announces one underground nuclear test at the Nevada Test Site during May 1968. (E.R.B.)

12084 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 9: 195-242(Apr. 1968). (RHD-Vol.9, No.4).

The continuing surveillance activities of the Public Health Service are reported. Separate abstracts were prepared on the four sections of this report. A separate abstract was also prepared on the summary of ^{55}Fe contamination in the environment and human body burdens. All data are presented in graphic or tabular form. (E.R.B.)

For abstracts of individual sections see: 12085–12089.

12085 SUMMARY OF ^{55}Fe CONTAMINATION IN THE ENVIRONMENT AND LEVELS IN HUMANS. Brill, Warren A. (National Center for Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 9: 195-201(Apr. 1968).

Levels of ^{55}Fe in the environment and in food sources were summarized. The average body burdens and resulting doses to the erythrocytes (red blood cells) of selected Alaskan Eskimos, and residents of the States of Washington, New York, and New Jersey are compared. Considering the erythrocytes as the critical organ, the dose rate from 1 pCi ^{55}Fe/mg stable iron is 0.095 mRad/yr. A body burden of 8 nCi, the average for Richland, Wash. residents, yields a yearly dose of 0.19 mRad, while 1,100 nCi, the average body burden for Eskimos on fish diets, yields a yearly dose of 26 mRad. (auth)

12086 MILK AND FOOD. Radiol. Health Data Rep., 9: 203-20(Apr. 1968).

The results of routine monitoring of radioisotope content of milk in the United States is reported by the Pasteurized Milk Network of the Public Health Service. Data on the ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr content of milk at participating stations for January to December 1967 are presented in tabular form. The ^{90}Sr content of pasteurized milk in the United States during 1963 to 1967 is also presented. The Canadian Milk Network presents the calcium, potassium, ^{137}Cs, and ^{90}Sr contents of milk at sampling station in Canada during December 1967. The potassium, ^{137}Cs, and ^{90}Sr contents of milk during December 1967 are tabulated for sampling stations of the Pan American Milk Sampling program. Data from the State Milk Surveillance Program are presented for October to December 1967 for Colorado, Florida, Oklahoma, Tennessee, and Texas. Concentrations of a variety of stable elements and radioisotopes in pasteurized milk are included for the reporting period. Institutional diets from selected areas of the United States were analyzed during July to December 1967 for content of calcium, potassium, ^{137}Cs, ^{226}Ra, and ^{90}Sr. These values were related to dietary uptake by children at the institutions by calculation of the average food consumption. (E.R.B.)

12087 WATER. Radiol. Health Data Rep., 9: 221-4(Apr. 1968).

The gross α and β radioactivity of surface waters from selected sampling sites in the United States is reported for October 1967. Samples of New York City tap water were analyzed during 1955 to 1967 for ^{90}Sr content and the monthly and yearly averages are presented in graphic form. The ^{137}Cs and ^{90}Sr contents of New York City tap water are also presented for January to June 1967 in tabular form. (E.R.B.)

12088 AIR AND DEPOSITION. Radiol. Health Data Rep., 9: 225-32(Apr. 1968).

Data from the continuous surveillance stations of the Radiation Alert Network are presented for December 1967. This represents the gross β radioactivity in surface air and precipitation samples from the network stations. Similar data are presented for December 1967 for Canadian stations by the Canadian Air and Precipitation Monitoring Program, for Mexico, by the Mexican Air Monitoring Program, and for Pan American countries, by the Pan American Air Sampling Program. (E.R.B.)

12089 OTHER DATA. Radiol. Health Data Rep., 9: 233-42(Apr. 1968).

Environmental levels of radioactivity during January to June 1967 are reported for the Berkeley, Livermore, and 300 sites of the Lawrence Radiation Laboratory. Results of atmospheric monitoring of polonium-210, plutonium-238 and tritium during January to June 1967, and offsite monitoring of water for the same nuclides are reported by the Mound Laboratory. The AEC announced four underground nuclear tests during March 1968 at the Nevada Test Site including one Project Buggy row-charge experiment. A series of five nuclear weapons tests were conducted by France during July to October 1966 and three low-yield weapon tests were announced by France during June and July 1967. (E.R.B.)

12090 REDUCTION OF RADIATION EXPOSURE IN NUCLEAR MEDICINE. **Proceedings of a Symposium Held at the Kellogg Center for Continuing Education, Michigan State University, East Lansing, August 7–9, 1967. Williams, Kenneth D.; Cooper, James F.; Moore, Raymond T.; Hilberg, Albert W. (eds.). Environmental Health Series–Radiological Health. Rockville, Md., National Center for Radiological Health, 1967. 153p. (PHS-999-RH-30; CONF-670836). Dept. of Health, Education, and Welfare, Free.**

Representatives from the nuclear medical community, industry, and governmental agencies attended a three-day symposium, August 7–9, 1967, cosponsored by the National Center for Radiological Health and Michigan State University. Formal presentations, discussion sessions, and work-group reports are included in the proceedings. Representatives of the Atomic Energy Commission and the National Center for Radiological Health defined the roles of these agencies in nuclear medicine. Professionals in the field of nuclear medicine presented the progress to date in the problem areas of internal radiation dosimetry, short half-lived radionuclides, instrumentation, radiopharmaceutical quality control, and manpower development. The work-group reports contain the conclusions resulting from a full day of work-group activity. The participants evaluated the need for reducing radiation exposure from nuclear medical procedures, formulated means that might be employed to use most efficiently the administered amount of radiopharmaceutical, and concluded with possible solutions to problem areas in nuclear medicine. (auth)

12091 APPARATUS FOR THE RADIOACTIVE DECONTAMINATION OF WATER. **Bovard, Pierre; Grauby, Andre. (to Commissariat a l'Energie Atomique). U. S. Patent 3,405,050. Oct. 8, 1968. Priority date June 21, 1963, France.**

A portable apparatus for decontamination of drinking water consists of a stacked array of filters contained in a closeable generally cylindrical housing and arranged between a water inlet tank and an outlet duct. A top inert filter is made up of a natural soil, such as talc, bentonite, or vermiculite confined between a pair of rigid semi-permeable plastic membranes. An electronic filter system is positioned below this natural soil filter and above a second inert filter similar in design to the first, but comprised of a mixture of diatomics, ion-exchange resins, or activated charcoal. A bacterial filter or some means of adding an appropriate disinfectant to the water before its discharge is arranged below the second inert filter. (B.L.M.)

12092 TRITIUM IN SURFACE WATERS OF THE UNITED STATES, 1966. Moghissi, A. A.; Porter, C. R. Radiol. Health Data Rep., 9: 337-9(July 1968).

During 1964 a tritium sampling network was established by the Public Health Service to measure the levels and consequently to determine the public health significance of tritium in surface waters of the United States. The analytical procedures used are described. Data for the samples obtained are presented. A means for estimating the radiation dose resulting from tritium in the body is developed. (auth)

12093 TRITIATED MOISTURE IN THE ATMOSPHERE SURROUNDING A NUCLEAR FUEL REPROCESSING PLANT. Daly, J. C.; Manchester, A. V.; Gabay, J. J.; Sax, N. I. Radiol. Health Data Rep., 9: 341-6(July 1968).

A new wide-area sampling technique was used to collect more than 700 tritiated moisture samples over a 2-month period from seven sampling legs radiating out from a nuclear fuel reprocessing plant. For the 28 sampling periods studied, the average tritium radioactivity on the sampling leg northwest of the plant exceeded 2,500 pCi/liter, 75 percent of the time and exceeded 10,000 pCi/liter, 39 percent of the time as opposed to ambient levels of <2,500 pCi/liter. The highest tritium level recorded was 26,400 pCi/liter. These data are reported not so much for their epidemiologic value as for their value to public health agencies contemplating radiological surveillance around nuclear facilities. (auth)

12094 MILK AND FOOD. Radiol. Health Data Rep., 9: 347-63(July 1968).

National and international milk surveillance network report on the ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr content of pasteurized milk for March 1968. The reporting networks include Canadian Milk Network, Pan American Milk Sampling Program, and Pasteurized Milk Network (USA). The average concentrations of these radionuclides for April 1967 to March 1968 is reported by the Pasteurized Milk Network. A graphical summary of the ^{90}Sr content of milk in the United States during 1964 to 1968 is also presented. State milk surveillance activities are reported for January to March 1968 for the states of Colorado, Florida, Tennessee, and Texas. Radionuclide concentrations were determined for ^{140}Ba, ^{137}Cs, ^{131}I, and ^{90}Sr. Concentrations of the stable element K were also reported. The institutional diet surveillance program of the Public Health Service presents data on the Ca, K, ^{137}Cs, ^{226}Ra, and ^{90}Sr content of children's (9 to 12 yr old) diets in institutions throughout the United States. Monitoring results are reported for October to December 1967 and the annual averages computed for 1967. All data are presented in tabular form. (E.R.B.)

12095 WATER. Radiol. Health Data Rep., 9: 365-70 (July 1968).

The gross α and β radioactivity of raw surface waters in the United States is presented for January 1968 from selected monitoring stations. The gross α and β radioactivity in raw surface waters, ground water, and raw water in Florida for 1965 is presented by bimonthly averages and yearly average. All data are in tabular form. (E.R.B.)

12096 AIR AND DEPOSITION. Radiol. Health Data Rep., 9: 371-8(July 1968).

The gross β radioactivity in airborne particulates and precipitation is recorded for March 1968. Monitoring stations in the surveillance networks of Canada, Mexico, Pan America, and the United States are included in the report. All data are in tabular form. (E.R.B.)

12097 OTHER DATA. Radiol. Health Data Rep., 9: 379-85(July 1968).

The long-lived gross α and β radioactivity of airborne particulates in the environs of Oak Ridge, Tennessee, is reported for January to June 1967. Other data reported for the same monitoring period include: ^{131}I and ^{90}Sr content of raw milk, radionuclide content of Clinch River, and external γ radiation levels in environs. The α and $\beta-\gamma$ radioactivity levels in the environs of the Portsmouth Area Gaseous Diffusion Plant are reported for July to December 1967. The United States Atomic Energy Commission announced three underground nuclear tests at the Nevada Test Site during June 1968 and recorded two seismic signals originating from the Soviet underground nuclear test area during June 1968. (E.R.B.)

12098 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 9: 337-86(July 1968). (RHD-Vol. 9, No. 7).

Separate abstracts were prepared on the two reports and four data sections in this journal. (E.R.B.)

For abstracts of individual sections see: 12092-12097.

12099 DOSIMETRIC AND BIOLOGIC PROBLEMS POSED BY ELECTRON BEAM THERAPY. Tubiana, M. (Institut Gustave-Roussy, Villejuif, France). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 178-84(Jan. 1969).

Although electron beam therapy is one of the most interesting acquisitions of radiotherapy during the past few years, numerous dosimetric problems remain to be solved by various approaches before it can be used routinely in clinical practice including the standardization of a dosimeter which is capable of measuring the absorbed dose in rads with sufficient accuracy; the standardization of beam energy; and the establishment of depth dose curves for treatment conditions. A common language is essential for intercomparisons between various clinical centers. Treatment planning must take into account the distortions produced by the contour of the patient and tissue heterogeneity. These are often more difficult to predict than with photons, and the use of appropriate phantoms may be necessary for their evaluation. The ratio of the RBE for high energy electrons to that for 200 kV x ray is, as for high energy photons, approximately 0.85 and does not appear to vary with depth. This, however, does not mean that a patient can be indiscriminately treated with one or other of these types of radiation, because the relative therapeutic effectiveness may also depend on dose distribution in the target volume and peritumoral tissue which differ from one patient to another. Thus, controlled clinical trials remain essential in evaluating the benefits which may result in the treatment of various forms of cancer with electron therapy. (auth)

12100 RADIUM DOSAGE PATTERNS IN THE TREATMENT OF UTERINE CARCINOMA. Spira, Jacob; Aral, Isamettin (Boston Univ.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 110-14(Jan. 1969).

In the radium treatment of endometrial carcinoma using Heyman's packing technique, variations in shape and size of malignant uteri become very important in evaluation of the dose delivered to uterine walls and the adjacent structures. Because of these difficulties, an unsatisfactory method of stating dosage in milligram-hours of radium has been retained in gynelogic curie therapy. An experimental program to determine the distribution of radiation along the periphery of the uterine wall as well as to structures of anatomic importance was developed. Multiple measurements were performed in different sizes of uterine models using Sievert miniature ionization chambers, lithium fluoride dosimeters, and slow films. A limited computer program was written to check the pattern of experimental measurements. The results were satisfactory and an extensive computer program was started to develop a system of complete radium dosage patterns for uterine cavities of different size and shape and their associated radium content. (auth)

12101 USE OF RECORDING SYSTEMS WITH TWO OUTLETS FOR DETERMINING ABSORBED DOSES IN A DISPERSED MEDIUM. Volkov, N. G.; Glezin, F. I.; Lyapidevskii, V. K. (Scientific-Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol., 14: No. 1, 38-42(Jan. 1969). (In Russian).

The development of the method of determining the dose with two detectors of varying energy dependence is described. For x-ray spectra passing through dispersed media the error does not exceed 3 per cent. The advantage of the above-mentioned method in comparison with routine dosimetric techniques consists in the use of semiconductor and scintillation detectors, which are endowed with a great sensitivity. (auth)(C.O.)

12102 IRRADIATION DOSE OF DIFFERENT HUMAN BONES IN ACCUMULATION OF ONE STRONTIUM UNIT. Khokhryakov, V. F.; Suslova, K. G. Med. Radiol., 14: No. 1, 15-18(Jan. 1969). (In Russian).

The results of determinations of calcium concentration in different skeletal bones of man are presented. The calcium content in one gram of raw tissue is different for each type of bone. It noticeably changes with age. Therefore, the dose loading, corresponding to one strontium-90 unit, may differ from the mean value for skeleton (2.7 mrad/year) by 1.5 to 3.8 times. (auth)

12103 APPLICATION OF A PERSONNEL MONITORING SYSTEM TO POPULATION DOSIMETRY OF BACKGROUND RADIATION. Shapiro, Jacob; Segall, Ascher; Worcester, Jane (Harvard School of Public Health, Boston). pp 625-33 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A field study was undertaken to evaluate the use of pocket ion chamber dosimeters for measuring population dose to background radiation. The chambers were charged to a low voltage to minimize leakage and read after exposure with a pulse-reading method. The method had a sensitivity reported to be 1 mR ± 0.2 mR. Special tests were devised for selection of stable and reproducible ion chambers. The dosimeters were worn by individuals for a week at a time over a five-week period and calibrated and standardized after each week of use. Results of an analysis of variance on the standardization data obtained with 41 dosimeters over the period of use are presented. The tests showed that after field use, the system, including reader plus dosimeters, showed increased variability over the variability at the beginning of the tests. The leakage of the dosimeters was also apparently increased in field use over that found in laboratory experiments. The study showed the need of frequent testing in the field of any system used for population dosimetry at the low levels characteristic of background radiation. The design of a study of population exposure to background radiation with personnel monitoring devices is discussed. Formulas are presented for determining the total number of dosimeters to use and the number of dosimeters to assign per individual, based on initial pilot studies. The test data obtained in this survey should be useful for comparison with test data on other dosimeter systems, such as the thermoluminescent type in evaluating the performance of detection systems for the measurement of low-level population exposure. (auth)

12104 ANALYSIS AND BALANCE OF RISKS ASSOCIATED WITH MANAGEMENT OF RADIOACTIVE WASTES. Duhamel, F. (CEA, Paris). pp 637-41 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The dangers that radioactive wastes present with respect to public health are not easily placed within the framework of the standards determined by the International Commission of Radiological Protection in order to define the orders of magnitude. The consideration of radiological toxicity thus defined does not, in this particular, give an indication of the actual danger. By analysis of this problem it can be shown that there are a certain number of cases, all different, in which the dangers should be considered in a special manner, admitting that biological toxicity plays only a secondary role with respect to certain physical characteristics. The present communication has the purpose of determining the essential parameters, or danger factors, on which attention should be focused and of evaluating the importance of these dangers in order to draw conclusions for the proper means of reducing them. (tr-auth)

12105 EXPERIMENTAL EVALUATION OF THE POSSIBILITY OF DIFFUSION OF GASEOUS EFFLUENTS FROM A NUCLEAR CENTER. Martin, J. J.; Roche, R.; Kieffer, J. (Electricite de France, Paris). pp 643-58 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The results of the diffusion measurements made on the site of the Ardennes power plant from May to October 1964 were analyzed. The distribution of the volume and surface contamination following experimental releases was evaluated with an approximation judged sufficient for the needs of radioprotection. The results of meteorological measurement carried out on the site from 1960 to 1965 are briefly presented. The experimental study permits the calculation of the deposition values applicable to the waste release to the atmosphere with respect to the norms of health protection. (tr-auth)

12106 PROBLEMS CONCERNING DISPOSAL OF RADIOACTIVE EFFLUENTS IN INTERNATIONAL RIVERS. Bojovic, P. S. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 669-71 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Difficulties encountered in the release of radioactive effluents into international rivers are reported. This problem becomes acute when it is considered that a very large number of the nuclear power plants of the whole world are located near international rivers or their branches. In posing this problem, the effect of the MPC values (maximum permissible concentration) of the water, the effect of the national contribution to the total output of an international river, and the effect of other factors are considered. In order to contribute to the solution of this problem, a formula to determine the activity of effluents which can be released into international rivers is proposed. (tr-auth)

12107 AN EVALUATION OF HAZARDS FROM IMMERSION OF PLUTONIUM IN THE MARINE ENVIRONMENT. Teresi, J. D. (Naval Radiological Defense Lab., San Francisco); Newcombe, C. L. pp 673-80 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The potential hazard owing to a single immersion and subsequent release of plutonium was evaluated on the basis of its possible incorporation in the marine food chains including the alga, Porphyra, and the seaweed products agar and alginic acid. The hazards were estimated by comparing the recommended permissible body burdens for large populations ($^1/_{10}$th occupational permissible body burden) with the expected body burden calculated on the basis of very conservative assumptions. The concentration of plutonium from a single release in the sea that would lead to the permissible body burden through the fish food chain was calculated on the basis of published concentration factors. The value of the concentration of plutonium to give this body burden was found to be 6.4×10^{-2} μCi/ml assuming a single intake of 200 gms of fish per individual. The expected body burdens from Porphyra, agar, and alginic acid were then calculated on the basis of the calculated plutonium concentration and the published concentration factor for seaweed. Calculations were also made of various diffusion parameters using six published diffusion models to obtain areas of contamination with time and the duration of a hazardous concentration. (auth)

12108 CONSEQUENCES OF THE CONTAMINATION INCIDENT AT THE SACLAY CENTER OF NUCLEAR STUDIES PILE EL-3 FROM THE STANDPOINT OF RADIATION PROTECTION. Fitoussi, L.; Lebouleux, P. (CEN de Saclay, Gif-sur-Yvette, France). pp 561-70 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A mechanical incident on a cellule having a cladding rupture caused a radioactive incident. This incident occurred during the transfer of the cellule from the reactor vessel to the storage vessel. An emission of fission products resulted in contamination of the air and of the walls of the storage vault that lasted for several days. After indication of the results of the contamination measurements made in the coolant fluids of the reactor, in the air, on surfaces, and in the installation chimney, observations made on the emission of fission products and their behavior under the conditions of the incident were presented. The consequences of the incident were also considered from the viewpoint of radioprotection. (tr-auth)

12109 ^{137}Cs IN THE PLANTS, PLANKTON, AND FISH OF THE FINNISH LAKES AND FACTORS AFFECTING ITS ACCUMULATION. Kolehmainen, S.; Haesaenen, E.; Miettinen, J. K. (Univ. of Helsinki). pp 407-15 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Bioaccumulation of ^{137}Cs in the freshwater organisms was studied during 1964 and 1965 by taking water, plankton, plant, bottom animal, and fish samples from water courses representing widely different limnological types: from eutrophic (rich in nutrients) to oligotrophic (nutrient deficient) lakes. It was shown that the ^{137}Cs content of all organisms sharply depends on the potassium content of the water. In lakes where this value is less than 1 mg K/l water, very high values of ^{137}Cs in fish were reached in 1965—maximum 26 nCi/kg fresh weight in perch (Perca flu-

viatilis L.). Quantitative estimations show that the four main factors determining the ^{137}Cs body burdens in the last link of the food-chain, the fish, are: ^{137}Cs content of water — a minor factor as observed differences in the lakes studied have been only about 2- to 3-fold. The limnological type of the lake — this is the main factor effecting 10- to 100-fold differences in the same fish species in different lakes. The quality of food eaten by the fish — a minor factor effecting 2- to 3-fold differences. The biological half-time of ^{137}Cs in fish — an important factor varying from 20 to 200 days at 15°C in different species and effecting up to 10-fold differences in various species in the same water course. The bulk of the ^{137}Cs intake takes place through food chains. Direct gill absorption plays a minor role only. (auth)

12110 A METHOD OF ASSESSMENT OF WHOLE-BODY INTEGRAL DOSE FOLLOWING ACCIDENTAL RADIATION EXPOSURE FROM AN EXTERNAL MOVING SOURCE. Langmead, W. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Hill, S. M. B. pp 479-89 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The dosimetry requirements following an accidental exposure of personnel to external radiation at an establishment of the U.K. Atomic Energy Authority are reviewed; in general the required information falls into two categories involving two distinct operations separated in time. There is an immediate need for dose data which will enable decisions to be taken regarding the appropriate medical treatment, if any, to be given to the exposed persons. Such dose data are usually obtained from the processing and evaluation of personnel films which were worn on the exposed person's body. At a later stage more refined determinations of absorbed doses received by critical organs of the body are required for record purposes and for medico-legal reasons. An important dose parameter which may be considered in this latter category is the integral dose to the whole body, defined as: Integral dose = M ∫ D.dm where D is the absorbed dose in Rads received by a mass element, dm, of the body, the product (D.dm) being integrated over the whole mass, M, of the body. The reasons for the importance of this function are discussed and a method for its determination is described, employing the so-called reciprocity dose theorem and taking as example a case of an accidental exposure at one of the Authority's establishments. The report concludes with an assessment of the accuracy of the determination and a discussion of the limitations of the method. (auth)

12111 RADIATION EXPOSURE FROM RADIOPHARMACEUTICALS IN CHILDREN. Kereiakes, J. G.; Wellman, H. N.; Saenger, E. L. (Univ. of Cincinnati). pp 775-81 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The average radiation doses to whole body and to certain organs were calculated for a selected population of children administered radiopharmaceuticals for diagnostic purposes. The thyroid uptake studies and dose calculations, collated with the findings of other investigators, suggest that thyroid tests for suspected disease in newborns, e.g., cretinism and inborn errors of thyroid metabolism, be made at least 1 to 2 weeks following birth unless the diagnosis becomes a life-saving procedure. The observations concerning other radionuclides indicate that both whole body and organ doses do not exceed those expected and that these labeled pharmaceuticals can be used in their accustomed doses safely in children. The findings are part of a continuing program for obtaining metabolic data in children to allow modifications of the dose calculations presented here and in previous reports and provide more accurate and complete estimates of radiation exposure. (auth)

12112 COMPARISON OF DOSIMETRIC FILMS USED IN THE SIX EURATOM COUNTRIES (PRELIMINARY RESULTS). Recht, P.; Collet, M. pp 115-18 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

In 1965, the Commission of Euratom—Direction of Health Protection—decided to proceed, in collaboration with the competent authorities of the member countries, with a comparison of the film dosimeters used in the various centers of the Community, with respect to the information which they give on the doses received. The experience was developed in the following manner: the study was made on x and γ dosimetric films; three irradiation regions were chosen within the limits 0 to 5 R, 4 to 30 R, and 25 to 400 R; each irradiation region was confined to a single center to which the establishments of the Community have taken their film; the films were read at the reading center with no information of the applied irradiation; the results of the irradiations and the reading were compared by the Direction of Health Protection; the irradiation tests were repeated four times for each region. The results are presented and discussed and show the degree of fidelity of the data given for each dose effectively received by the film dosimeters. (tr-auth)

12113 PERSONNEL FILM MONITORING IN POLAND: ORGANIZATION, METHOD, RESULTS. Musialowicz, Tadeusz (Central Lab. for Radiological Protection, Warsaw). pp 119-22 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Since 1959 the Central Laboratory for Radiological Protection (CLOR) has been carrying out a centralized personnel monitoring service for radioisotope laboratories and nuclear installations in Poland. X-ray laboratories are centrally monitored by the Institute of Labour Medicine. Films used by CLOR for gamma, beta, thermal-neutron and x-ray radiation measurements are those made by the Polish photochemical factory Foton. The measurement range for gamma rays of ^{60}Co is between 60 mR and 1300 R. Kodak PNM films type A have been used for fast neutron dosimetry. To evaluate the statistics of occupational exposure the results of yearly checkups are grouped according to: Dose values: up to 0.5 Rem/yr; 0.5–1.5 Rem/yr; 1.5–5 Rem/yr; 5–12 Rem/yr; 12–25 Rem/yr; above 25 Rem/yr. Age groups: 18–30 yr; 31–40 yr; 41–50 yr; over 50 yr of age. Type of establishment: research; industry; medicine; other. The number of persons monitored by the CLOR ranged from 800 in 1959 to 4500 in 1965. On the average about 80% of the monitored persons received doses below 0.5 Rem/yr and about 0.2% received doses over 12 Rem/yr. (auth)

12114 PRACTICAL PERSONNEL DOSIMETRY OF THERMAL NEUTRONS. Nachtigall, D. (EURATOM, Geel, Belg.); Rose, E. pp 123-30 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The energy doses and dose equivalent per unit flux of thermal neutrons and their pattern along various axes were determined with an electronic computer for a model thorax of standard tissue with the dimensions of 80 × 40 × 20 cm. The contribution of the (n,γ) reactions in hydrogen and of the (n,p) reactions in nitrogen was especially considered. The calculations as well as measurement on reactors, accelerators, and thermal columns showed that in practice radiation protection by the carrying of a γ personnel dosimeter can be relinquished to a special personnel dosimeter for thermal neutrons. (tr-auth)

12115 PHOSPHATE GLASS DOSIMETER FOR RADIATION PROTECTION APPLICATIONS. Buttler, W. (Total KG, Ladenburg, Ger.); Maushart, R.; Piesch, E. pp 131-3 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A new dosimeter is described that seems to be suited for radiation protection applications on the basis of experiments and test results of a recently developed catastrophe dosimeter system. It contains a cylindrical phosphate glass 8 mm in diameter which is firmly bound to a part of the capsule that bears the identification sign. It permits determination of γ doses of 50 mR to 1000 R. The dosimeter is airtight, moisture-proof, and filter-compensated for production of a small energy and direction dependence. The design of the filter capsule makes possible a fast and easy evaluation. (tr-auth)

12116 ORGANIZATION OF RADIATION PROTECTION AT THE NUCLEAR CENTRAL OF CHINON. Delpla, M. (SGR-EDF, Paris); Bigeard, C.; Bertron, L.; Ventre, E. pp 223-30 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

On the Chinon site are the first three reactors constructed and operated by Electricité de France (E.D.F.). In all electric plants, with few operational personnel, or with the consequences of negligence can be dramatic, each agent should respect rigorously all orders. The radioprotection has been organized by following as far as possible the orders relative to conventional security and on the principle of self-protection. By reporting how the radioprotection is integrated in the operation of the Chinon nuclear plant, and by making more precise the responsibilities of each (hierarchic and functional responsibility), a resume is presented of the difficulties which appeared in the setup of this organization, in particular, concerning the formation of the personnel, the adaptation of workers to a contaminated medium, and the occurrence of technicians foreign to the plant. (tr-auth)

12117 RAPID FIELD METHOD FOR THE COLLECTION OF RADIONUCLIDES FROM MILK. Porter, Charles R. (Southeastern Radiological Health Lab., Montgomery, Ala.); Carter, Melvin W.; Kahn, Bernd; Pepper, Estie W. pp 339-46 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Surveillance of the radionuclide content of milk is simplified by concentrating the radionuclides on ion-exchange resins. In the field, EDTA added to milk samples complexes calcium ions and prevents loading of the cation-exchange resin by calcium. One-liter samples of milk are then passed consecutively through 40 ml of anion-exchange and 85 ml of cation-exchange resin at a rate as great as 100 ml/min. The resins retain the fission products that enter cows' milk—radioiodine by anion-exchange, and radiostrontium, radiobarium, and radiocesium by cation-exchange. The resin columns are washed with water, sealed, and shipped to the laboratory for analysis. In the laboratory, iodine-131, barium-140, cesium-137, and naturally occurring potassium-40 are determined by gamma spectral analysis of the resin columns. Radiostrontium and radiobarium are eluted from the cation resin with 4N sodium chloride and radiobarium is separated as the chromate. Radiostrontium is then reprecipitated with strontium carrier as the carbonate, and measured in a low-background beta counter. Strontium-90 is distinguished from strontium-89 by the ingrowth of the yttrium-90 daughter. Transporting the resin columns from field to laboratory is simpler and more economical than shipping bulk milk samples, and loss of samples in transit is minimized. The columns allow complete analysis of the cited radionuclides in that more than 95% of each is collected on the resin. Sample concentration is rapid, occurring in less than 15 min. By comparison with liquid milk analysis on 3.5-liter samples, gamma spectral analysis is more sensitive than other methods because of increased counting efficiencies resulting from the small volume of the resin, and radiochemical analysis of the radiostrontium is a rapid, simple procedure. (auth)

12118 ACCURACY CONTROL IN LOW-LEVEL MEASUREMENTS. Ferraris, M. M.; Merten, D. (IAEA, Vienna). pp 313-20 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

One practical way to determine the accuracy of low-level measurements consists in organizing series of intercomparison measurements among the largest possible number of qualified laboratories. These measurements should be executed on samples possessing the same characteristics as those which are routinely employed, and following the same measurement techniques. The IAEA has been organizing intercomparison measurements since 1964 and the results of these two years confirm the necessity of this intercomparison. The following samples have been analyzed: milk, soil, rice, meat, bone, different kinds of vegetables and a mixture of dried food. The following radionuclides have been determined: ^{90}Sr, ^{137}Cs, ^{226}Ra, ^{210}Po, and the stable elements calcium, strontium and potassium. The results obtained cover a wide range. Statistical analysis proves the existence of systematical and accidental errors, the first being easier to identify than the second. It has been observed that some laboratories which at the beginning of the measurement series gave results which were far from the average, have little by little improved their findings after the results of other laboratories were made known to them. The participation, except for some items and some radionuclides, has been quite remarkable, about 80 laboratories in 27 countries. It is hoped that the number of laboratories participating in this intercomparison will still increase, so that all data in relation to the environmental radioactivity may be comparable. (auth)

12119 DETERMINATION OF ^{226}Ra IN NATURAL SAMPLES. di Ferrante, Elvira R. (EURATOM, Ispra, Italy); Koch, Georges; Boulenger, Rene R. pp 321-8 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The natural content of ^{226}Ra in environmental samples was determined by the emanation technique. The reliability and sensitivity of the method made measurements possible at a very low level. Analyses of human teeth could, for instance, be performed satisfactorily and the concentrations obtained, ranging from 0.008 to 0.138 pCi/g ash, are in agreement with the literature data. The highest ^{226}Ra contents found are of the order of 1, 2 and 6 pCi per gram of calcined material. The chemical preparation of the different samples such as milk, bones, teeth and minerals is described. Detailed description of the apparatus with schematic diagram and of the measurement technique is also given. The equation used for the calculation of the activity expressed in pCi ^{226}Ra/g ash or pCi ^{226}Ra/l, is shown. (auth)

12120 DOSE TO TRABECULAR BONE FROM INTERNAL BETA EMITTERS. Spiers, F. W. (Medical Research Council, Leeds, Eng. Univ. of Leeds, Eng.). pp 165-72 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Consideration is first given to the general structure of trabecular bone and to the location of tissues within it that are relevant to possible radiation damage, namely active bone marrow, as the blood-forming tissue, and endostical tissues close to trabecular surfaces. For dosimetric purposes, data are required on the dimensions of the trabecular cavities and of the over-all dimensions of the trabecular parts of the cortical thickness in different bones. Investigations are described by which these physical characteristics have been obtained. Methods of calculation of the mean marrow dose and the mean dose to endosteal surfaces are discussed and results given for individual bones, and for the whole skeleton, for the radioisotopes ^{14}C, ^{45}Ca and ^{90}Sr. The implications of β-particle dosimetry in trabecular bone for the setting of maximum permissible levels of β-emitters in bone are briefly discussed. (auth)

12121 PERSONAL DOSIMETRY: METHODS OTHER THAN T.L.D. Ehrlich, Margarete (National Bureau of Standards, Washington, D. C.). pp 69-76 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

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Papers on various methods of personnel monitoring are included. In a paper on beta-gamma calibration in photographic dosimetry, four different types of film were compared and it was concluded that Mafe film was best suited for personnel monitoring. A paper is presented on the design and construction of a transportable calibration facility for film dosimetry of x rays by means of radioactive sources. The design of a new badge is discussed; it contains indium foil, copper, sulfur, and cadmium for emergency neutron monitoring. A phosphate glass dosimeter adapted to the requirements of health physics application is described. Organization, methods, and results of personnel film monitoring in Poland are discussed. A discussion of practical personnel dosimetry of thermal neutrons is presented. A paper is included on automatic data processing of a film badge service. A study was conducted in six Euratom countries for comparing monitoring devices. The calibration laboratories prepared a report to give results to the participating services. The study helped the services to obtain better calibration curves without their having to do any high-precision calibrations themselves and it helped them to improve their equipment and procedures. (H.L.W.)

12122 NEW CONCEPT IN FILM BADGE DESIGN. Eastes, J. D.; Maurer, M. L.; Paschal, F. L. (General Dynamics/Fort Worth, Tex.). pp 77-89 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Unique concepts are incorporated into a new personnel monitoring badge which include a basic structural design to permit various options in the choice of dosimetric accessories, unusual mechanical features for operational improvements, and a specific film-filter system and an unusual new technique for dealing with the film energy dependence problem. The basic structure of the badge consists of three molded plastic components which can be assembled or disassembled in a matter of seconds. When assembled the structure is locked together with a tamper-proof locking system. The components are designed to collectively contain two dental size film packets in separated compartments (each opposed by matched filter systems), a system of high range dosimetry devices in two other compartments, and identification and/or security credentials. The high range dosimetry compartments and the areas designated for the filter system are designed to afford numerous options in the choice of components for these systems. Individualized film compartments permit the use of either one or two film packets in the badge and make possible the selective exchange of film packets in a simple manner. A unique locking device serves a dual purpose as a lock when the badge is closed and as a catch which prevents the complete disassembly of the components when the badge is being serviced. The locking system is also unique in that only one magnet is required to open the badge even in automated operations. A specific filter system which consists of five different filters is utilized to accomplish routine dosimetry for beta, gamma, x-, thermal neutron and fast neutron radiations. Dosimetry for beta, gamma, x-, and thermal neutron radiations is accomplished with the same film. The major problem in film dosimetry, energy dependence, is treated in a unique new manner with this filter system, which permits the evaluation of mixed exposures involving photon radiations in the critical energy region with greatly improved accuracy. The technique utilizes an energy index factor which is the ratio of the sum of densities behind two filters to the sum of densities behind two other filters. The photon dose in the critical region is determined from the sum of the excess densities behind three relatively thin filters as compared to a thicker filter, using the apparent energy indicated by the index factor. The density under the thick filter in excess of that predicted for the apparent exposure in the critical energy region is attributed to high energy photons. The filter system and techniques related to those just mentioned permit the evaluation of mixed exposures involving the four types of radiation mentioned previously. A simple mathematical development of the energy index and low energy dose factors are presented and the film dosimetric capabilities attainable with the system have been verified with appropriate testing; however the test results are not included in this report. The badge has been in use since January 1965 and has proven very satisfactory in routine use and in the evaluation tests. The test results show that the film dosimetry capabilities attainable with the system described greatly exceed proposed standards. (auth)

12123 AUTOMATIC DATA PROCESSING FOR A NATIONAL FILM DOSIMETRY SERVICE. Benary, W.; Schatz, M.; Ben-David, G. (Israel Atomic Energy Commission, Yavne, Israel). pp 91-3 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The operation of a national film dosimetry service involves a considerable amount of documentation, including regular badge dispatch lists, a dosage information bulletin sent to each organization, and full records of individuals and organizations using the service. The smooth operation of the dosimetry service depends on the regular flow of this documentation. Automatic data processing has been introduced to handle all the documentation of the Soreq Dosimetry Service, which acts as a national scheme for all industrial and medical applications of radiation. This results in a fully flexible system, capable of meeting increased demands without a corresponding increase in the personnel required for documentation. The use of an electronic computer results in considerable saving in manpower and a reduction in errors, and permits convenient storage of all the recorded dosage statistics on magnetic tape. (auth)

12124 PLUTONIUM CONTAMINATION OF LARGE LAND AREAS. Johnson, William S. Sr. (Eberline Instrument Corp., Santa Fe, N. Mex.). pp 379-83 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The contamination of large land areas with significant quantities of plutonium has been essentially a situation unique to the non-nuclear detonation of nuclear weapons. However, with the increased use of Pu-239 for non-weapons applications and the availability of Pu-238 in quantity, health physicists need information on the magnitude of the contamination associated with plutonium accidents. The results of the most extensive field experiments to date, Operation Roller Coaster sponsored by the United States and the United Kingdom, provide an insight into the radiological problems of such accidents. As is the case in any true accident involving radioactive material, it is necessary to function and evaluate under conditions entirely different from routine plutonium operations. Special equipment was field tested to enhance plutonium detection by low energy electromagnetic radiations in addition to more conventional alpha monitoring. These techniques may be applied to improve personnel safety and to speed up the collection of radiological measurements where Pu-238, Pu-239, Am-241 and other transuranic elements are involved. (auth)

12125 SOME BIOGEOCHEMICAL CONSIDERATIONS ON THE RADIOACTIVE CONTAMINATION OF MARINE BIOTA AND ENVIRONMENTS. Fukai, Rinnosuke (IAEA, Monaco). pp 391-4 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The problem of the radioactive contamination of marine biota and environments can be regarded as the successive links of biogeochemical processes in the sea, in view of the transfer of radioisotopes from one geochemical sphere to the other. In the present paper the importance of the accumulation of biogeochemical data concerning the distribution of trace elements in marine biota is emphasized in relation to the prediction of radioactive contamination. The significance of obtaining the standard abundance of trace elements for various groups of marine organisms is discussed by presenting some examples. In order to avoid misunderstanding, the significance of the term concentration factor or enrichment factor is critically reviewed and the use of the term abundance ratio is proposed. In aid of the accumulation of comparable data on the trace element distribution in marine biota, remarks are made on the expression and the interpretation of the analytical results and on the computations of the abundance ratio. (auth)

12126 RADIATION PROTECTION ASPECTS OF CONTROL OF RADIOACTIVE CONTAMINATION OF FISH. Feldt, W. (Isotopenlaboratorium der Bundesforschungsanstalt fuer Fischerei, Hamburg). pp 395-400 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The problems of the radiation protection monitoring for ocean and fresh water fish were discussed. After a review of the ecological role of Sr and Cs, the contamination values of ^{90}Sr and ^{137}Cs in fish were reported. Experimentally obtained discrimination factors and a simple calculation model permitted the calculation of the fish contamination from the contamination of the water and the reverse. The concentration factors of some radionuclides were reported as a function of the salt content of the water. On the basis of the results reported, appropriate fish monitoring was discussed. The transfer of radioactive nuclides to men from fish was estimated. (tr-auth)

12127 RADIATION PROTECTION. PART 1. Proceedings of the First International Congress held in Rome, Italy, September 5-10, 1966. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. 817p. (In Several Languages). (CONF-660920-(Vol.1)).

Separate abstracts were prepared for 66 papers presented at the conference. Abstracts of eight papers have appeared in previous issues of NSA. (H.L.W.)

For abstracts of individual papers see: 11439, 11629, 11661, 11662, 11676, 11805, 11806, 11874–11883, 12030–12037, 12055–12057, 12103–12126, 12128, 12129, 12180, 12181, 12226, 12232–12234, 13495, 13530, 13531, 13551, 13554, and 13555.

12128 DEVELOPMENT OF HEALTH PHYSICS AS A PROFESSION. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). pp 3-10 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

A brief history is given of the growth and development of health physics as a scientific profession. It is indicated that scientists and engineers from many disciplines have pooled their interests, combined their efforts and focused their attention on the central objective of providing adequate radiation protection for man and his environment from the harmful effects of ionizing radiation while at the same time enabling him to make better use of the benefits of this great source of energy. These scientists are engaged in education, training, administration, applied activities, engineering and research. Health physics research covers a wide spectrum of problems ranging from the effects of radiation on the living cell and on man to its interaction with matter at the atomic and nuclear levels. Ultimately, the goal of the health physicist is to develop a coherent theory of radiation damage, to assure that he measures and evaluates the proper physical and biological parameters related to the significant forms of potential radiation damage, to establish adequate radiation protection recommendations and measures at the national and international levels and to enforce these in such a manner that the benefits of ionizing radiation far outweigh the damage. Although the Health Physics Society, organized in 1956, was surprisingly successful in developing an international radiation protection organization, it was actually only partly successful in reaching this objective because there were some countries from which there were no members and many persons referred to it as the American society; this led to the formation of the IRPA and the calling of this international congress on radiation protection 10 years after the Health Physics Society was organized. Many old and new problems on a local, national and international level remain to be solved by the health physicist. A few of these problems are given for illustration and are discussed briefly. (auth)

12129 PERMISSIBLE DOSES FOR CRITICAL TISSUES. Pochin, E. Eric (Medical Research Council, London. University College Hospital Medical School, London). pp 11-15 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

If dose rates regarded as permissible for occupational exposure of different critical organs or body tissues need to be determined less in respect of any likely impairment of organ function at these dose rates than of the risk of neoplastic change or relevant genetic effects, the criteria on which such dose rates are determined ought to be related to any available quantitative information as to the sensitivity of the various human tissues and cell types to such changes. Possible bases for such comparisons are reviewed. (auth)

12130 METHOD OF CORRECTION OF STANDARD ISODOSE CURVES FOR X RADIATION IN THE PRESENCE OF PULMONARY HETEROGENEITY. Fadeeva, M. A.; Shagimardanov, N. Sh. (Scientific-Research Inst. of Roentgen-Radiology, Moscow. Scientific-Research Computer Inst., Moscow). Med. Radiol., 14: No. 1, 49-53(Jan. 1969). (In Russian).

A formula is described for determining the correction coefficient for heterogeneity to standard isodoses of x radiation with $E_{eff} = 80$ to 110 keV. This formula was evolved as the result of analysis and mathematical treatment of experimental data obtained by measuring doses in a heterogeneous plate phantom. As an imitator of soft tissue of pulmonary tissue, rubber sponge was used. (auth)

Medicine

Refer also to abstracts 11529, 11809, 11868, 11937, 11939, 11994, 12028, 12061, 12090, 12099, 12214, and 13178.

12131 (AEC-tr-6646/4A) RECOVERY OF IRRADIATED CELLS AND ORGANISMS BY NUCLEIC ACIDS. Proceedings of the International Symposium, held from June 23-24, 1966, Herceg Novi, Yugoslavia. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., 1-190(1966). 173p. (CONF-660634). Dep. CFSTI.

Separate abstracts were prepared for 28 papers presented at this symposium. (H.L.W.)

For abstracts of individual papers see: 11928-11939, 12045-12047, 12132-12140, 12191, 12227, 12236, and 12237.

12132 (AEC-tr-6646/4A, pp 83-9) RESTORATION OF X-RAY DAMAGED PLANT TISSUE CULTURES BY NUCLEIC ACIDS AND RELATED PRODUCTS. Duarte, M. I.; Ruch, C.; Bouriquet, R.; Jonard, R.; Kovoor, A. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

A review of the literature on plant growth-stimulating factors and their influence on restoration of radiation damage is presented. It was found that coconut milk, which contains indoleacetic acid and a kinin derived from nucleic acids, was not able to restore radiation damage in Scorzonera crown gall. However, a fraction prepared from yeast RNA promoted restoration of radiation damage. An extract of tobacco leaves was shown to be capable of restoring cultures of tobacco crown gall tissue after irradiation. It was thought that a kinin derived from nucleic acids was responsible for the restoring effect. (H.L.W.)

12133 (AEC-tr-6646/4A, pp 91-6) SOME ASPECTS OF THE EFFECTS OF NUCLEIC ACIDS ON SURVIVAL OF IRRADIATED ANIMALS. Wilczok, T. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

A review of the literature on radioprotective effects of nucleic acids is presented. Results obtained by various workers from studies on protective effects of homologous and heterologous DNA against lethal doses of radiation are discussed. Studies on molecular weights of DNA showed that DNA of higher molecular weights had greater therapeutic efficiency. Effects of γ radiation on the differential blood count of rats were studied; following treatment with DNA the blood picture was normal after the fifth day following irradiation, but seven to twelve days were required for restoration when sodium chloride was substituted for DNA. Studies on post-irradiation injection of tritium-labeled DNA led to the following hypothesis: DNA can circulate in the blood stream in a native macromolecular state where it adsorbs to lymphocytes; these cells or their fragments carry it to the bone marrow and the lymphatic tissues; thus the exogenous DNA is made available in situ to cells and tissues for repair of radiation damage. Effects of DNA on immunological properties of irradiated animals are discussed. (H.L.W.)

12134 (AEC-tr-6646/4A, pp 103-6) THE EFFECT OF NATIVE, DENATURED, RENATURED, AND DEGRADED DNA ON THE SURVIVAL OF LETHALLY IRRADIATED RATS. Mendecki, J.; Wilczok, T.; Neumann, H. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Rats were given 1000 R of γ radiation and injected intraperitoneally with the following DNA preparations: native, denatured, renatured, degraded native, degraded denatured, single stranded, and DNase-treated. Control rats were injected with sodium chloride. A table is presented to show percent survival after 30 days of the rats treated with different DNA preparations. Control animals died within 19 days. After 30 days, the survival of rats given native DNA was 62%; that of rats given denatured DNA was 57%; renatured, 60%; degraded native, 0%; degraded denatured, 0%; single stranded, 32%; and DNase-treated, 0%. The significance of the molecular weights of the various DNA preparations in relation to survival of rats is discussed. (H.L.W.)

12135 (AEC-tr-6646/4A, pp 107-10) RESEARCH ON THE KINETICS OF DEATH AFTER WHOLE-BODY IRRADIATION WITH X RAYS OR GAMMA RAYS. Neumann, H.; Wilczok, T.; Mendecki, J. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Rats were irradiated at various dose rates and treated with DNA or sodium chloride. In attempting to get a maximum number of survivals of animals with radiation sickness after LD 100 treatment with DNA, the radiobiological threshold effect was obtained within a dose range of 1 to 2 R/min. Animals irradiated with LD 100 at high dose rates did not survive the radiation sickness despite DNA treatment, while rats given the same total dose but at dose rates of only 1 to 2 R/min exhibited 30 to 80% survival when treated with DNA. Control rats treated with sodium chloride all died within a period of 15 to 30 days. (H.L.W.)

12136 (AEC-tr-6646/4A, pp 111-13) DNA REPAIR OF RADIATION DAMAGE IN THE CIRCULATING BLOOD OF RATS. Golba, Stanislaw; Golba, Maria; Wilczok, Tadeusz. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Exogenous DNA administered to rats after irradiation with a lethal dose of γ radiation had a significant effect on the survival weight and the recovery of erythrocytes, hemoglobin and white cell count in the circulating blood. Highly polymerized DNA from calf thymus was injected intraperitoneally within 48 hrs after irradiation. Control rats were given sodium chloride. Seven days after irradiation the erythrocyte count began to decrease; however, within 30 days the count returned to normal in the DNA-treated rats. In control rats the count decreased and death occurred within three weeks. The leukocyte count decreased drastically during the first 24 hrs after irradiation in all rats, reaching its lowest value after three days. From the 14th day after irradiation a great increase in leukocyte count was observed in the DNA-treated rats, but not in control rats. (H.L.W.)

12137 (AEC-tr-6646/4A, pp 121-5) THE EFFECT OF DNA AND OTHER HUMORAL FACTORS ON RECOVERY OF HAEMATOPOIETIC TISSUE. Juraskova, Vera; Drasil, V.

Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Mice were given a 650 R dose of x radiation and were then injected intraperitoneally with DNA, milk, thymidylic acid, and ascites tumor cells. Control mice were given saline solution. Recovery of hematopoietic tissue was determined using the spleen colony method. The tabulated results show that all substances increased the number of colonies. (H.L.W.)

12138 (AEC-tr-6646/4A, pp 127-32) RECOVERY OF REPRODUCTIVE ABILITY BY HOMOLOGOUS TESTES, LIVER, SPLEEN, THYMUS, AND KIDNEY DNA OF RATS IRRADIATED DURING THE INFANTILE PERIOD. Savkovic, N. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Male rats, aged 8 and 17 days, were given 600 R of x radiation. One group was treated with DNA extracted from kidney, liver, spleen, testes, and thymus. On reaching maturity the rats were mated with normal females. Fertility of males was estimated from the number of pregnant females and histological examination of the reproductive organs. Results showed that it was possible. Results showed that reproductive organs recovered from radiation damage when treated with DNA from the various organs. It is thought that nucleic acids repair the structure of the damaged nucleic acids in the irradiated organism. (H.L.W.)

12139 (AEC-tr-6646/4A, pp 133-7) RECOVERY EFFECT OF HIGHLY POLYMERIZED HOMOLOGOUS TESTIS AND LIVER DEOXYRIBONUCLEIC ACID (DNA) ON THE SEMINIFEROUS EPITHELIUM OF X-IRRADIATED RATS. Popovic, A.; Pantic, V.; Kanazir, D.; Jovovic, D. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Male rats were x-irradiated with doses of 500 and 750 R. DNA from testis was injected intraperitoneally into rats given 500 R, and DNA from liver was injected into rats given 750 R. Microscopic examination of testes showed that in rats treated with DNA there was less damage to the seminiferous epithelium and greater survival of spermatogonia and spermatocytes. (H.L.W.)

12140 (AEC-tr-6646/4A, pp 151-4) EARLY EFFECTS OF THE HOMOLOGOUS DNA OF IRRADIATED L-STRAIN CELLS. Neskovic, B. A.; Milosavljevic, A.; Bugarski, M.; Pantelic, M.; Ajdaric, Z.; Nikolic, S. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

DNA was introduced into a culture of L cells immediately after the cells were γ-irradiated with a dose of 700 rads. Photomicrographs were made at regular intervals for ten days. The photographs were analyzed for duration of interphase, transition from one interphase to the next, time when the first normal mitosis appears, time when endoreduplication appears, time when pathologic mitosis appears, and number of cells one hour after irradiation and after 41, 144, 202, and 228 hours. The effect of radiation was to slow down the mitotic process during the first 48 hrs. The number of cells in DNA-treated cultures increased by 100% in 41 hrs. The first appearance of endoreduplication of chromosomes occurred after 19 hrs in cells with exogenous DNA, and at the 25th hr in cells without exogenous DNA. (H.L.W.)

12141 (BARC-352) INVESTIGATIONS ON BASIC MECHANISMS OF RADIOSENSITISATION BY CHEMICALS. Singh, B. B.; Srinivasan, V. T.; Bhatt, B. Y.; Shenoy, M. A. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 23p. Dep.

The effects of chemicals on the γ-radiosensitivity of bacteria were investigated. Data are included on the effects of vitamin K_3, iodoacetamide, and iodoacetic acid on the sensitivity of Escherichia coli and Staphylococcus aureus. (C.H.)

12142 (CEA-tr-A-1944) SCINTIGRAPHY OF TUMORS BY MEANS OF RADIOACTIVE MERCURY COMPOUNDS ($^{197}HgCl_2$ AND ^{197}Hg-NEOHYDRIN). Wolf, R.; Fischer, J. Translated into French from Radionukl. Klin. Exp. Onkol., Deut., 15: 223-8(1965). 11p. (In French). Dep.

Application of $^{197}HgCl_2$ and ^{197}Hg-neohydrin to the scintigraphy of tumors and the results obtained were compared. The clearance of $HgCl_2$ was much slower than that of neohydrin. Sixty per cent of the neohydrin was eliminated in the urine within 24 hrs; but only 3% of the $HgCl_2$ was eliminated in this way during the first six days. In the positive scintigraphy of tumors much better results were obtained with $HgCl_2$. The most receptive organ for both compounds was the kidney. (J.S.R.)

12143 (COO-1267-3) IN VIVO MEASUREMENT OF REGIONAL CIRCULATION USING RADIOISOTOPES. Progress Report. Bacaner, Marvin (Minnesota Univ., Minneapolis. Medical School). [nd]. Contract AT(11-1)-1267. 8p. Dep. CFSTI.

The distribution of coronary blood flow in the canine left ventricle was studied in vitro using a double-label control technique. The regional distribution of ^{86}Rb and ^{45}K suggested that coronary circulation was regionally heterogeneous. Preliminary results are reported from in vivo studies on regional blood circulation in the myocardium of dogs in which the uptake and distribution of β-emitting ^{45}Ca or ^{14}C were measured by insertion of miniature solid state detectors mounted in a needle into the blood. (C.H.)

12144 (COO-1601-15) MICRORADIOGRAPHY OF THIN BONE SECTIONS. Progress report. [Ledley, Robert S.; Ray, Robert D.] (Illinois Univ., Chicago). Dec. 15, 1968. Contract AT(11-1)-1601. 4p. Dep. CFSTI.

A method for contact microradiography of thin bone slices is described. The exposed film and photomicrographs are scanned by an automated densitometer and data are analyzed by computer programs to obtain parameters relating to microstructure of the bone. The data obtained may be used to accurately evaluate bone density distribution over a given volume of bone. Possible applications in the early detection of pathological changes in bones are discussed briefly. (C.H.)

12145 (JPRS-45483) SPACE BIOLOGY AND MEDICINE. Vol. 2, No. 1, 1968. Translation of Kosm. Biol. Med., 2: No. 1, 3-90(1968). 136p. CFSTI.

Separate abstracts were prepared for two of the articles in this translation of the Russian-language journal Space Biology and Medicine. Sixteen additional articles on various aspects of space biology are included. (H.L.W.)

For abstracts of individual papers see: 12146 and 12195.

12146 (JPRS-45483, pp 21-6) CHANGE IN THE NATURE OF THE RADIATION PROTECTIVE EFFECT OF PROPYL GALLATE DURING PROTON IRRADIATION OF POTATOES. Shaydorov, Yu. I.; Gertsuskii, D. F.; Skukina, I. S.; Nikitina, I. V.; Alekseenko, L. V. Translated from Kosm. Biol. Med., 2: No. 1, 18-21(1968).

The radioprotective effect of propyl gallate on the growth and development of potatoes was studied. Isolated potato eyes were exposed to ^{60}Co γ rays and 660 MeV protons. Propyl gallate reduced the inhibitory effect of ^{60}Co γ radiation on potato growth and yield, and increased the inhibitory effect of proton irradiation. (auth)

12147 (NYO-910-75, pp 2-10) RADIOACTIVE ISOTOPE INSTRUMENTATION, DATA ANALYSIS, AND ORGAN SCANNING STUDIES. Laughlin, John S.; Mayer, Klaus; Kenny, Peter; La Monte, Charles; Hasan, Saad; Woodard, Helen Q. (Sloan-Kettering Inst. for Cancer Research, New York).

A data display system was developed for the quantitative representation and handling of computer-analyzed scan data obtained with a positron camera during metabolic studies using ^{47}Ca, ^{51}Cr, ^{59}Fe, ^{131}I, or ^{85}Sr as tracers. A digital Anger camera was constructed to permit quantitative stationary imaging of radioisotope distribution in vivo during metabolic studies. The detectors may be used individually with collimation for single γ emitters or in coincidence without collimation for positron emitters. A theoretical method was developed for calculation of the spatial response of a scintillation detector collimated by a multihole focusing collimator. Techniques were developed for use in erythropoietic function studies in man using ^{99}Tc-sulfide colloid, ^{52}Fe, or ^{59}Fe as tracers with high-energy γ-scanning systems. The usefulness of quantitative scanning and photoscanning was compared for the detection of malignant neoplasms in the brain following the injection of ^{99}Tc-pertechnetate, and in the liver following injection of ^{131}I-rose bengel or colloidal ^{198}Au. Results showed that quantitative scans were more accurate for the early detection of cerebral malignancies while digital scans of the liver permitted comparisons of function at different areas and was useful in serial studies. (C.H.)

12148 (NYO-910-75, pp 10-26) METABOLIC STUDIES IN PATIENTS WITH BONE AND PARATHYROID DISEASE. Myers, W. P. Laird; Laughlin, John S.; Greenberg, Ernest; Dimich, Alexandra; Rothschild, Edmund; Kenny, Peter (Sloan-Kettering Inst. for Cancer Research, New York).

Radioisotope scanning techniques for the diagnosis and localization of bone neoplasms and hyperfunctioning parathyroid tissue were investigated. Data are included on the kinetics of the uptake and distribution of ^{47}Ca, ^{18}F, ^{68}Ga, ^{85}Sr, and ^{87}Sr in human bones. It was concluded that the short-lived bone-seeking radionuclide ^{18}F was the most suitable for bone scans performed within five hr of injection of the radioisotope. Preliminary results are reported from ^{47}Ca and ^{85}Sr tracer studies on the effects of γ- or x-radiotherapy on the metabolism of Ca in bones invaded by metastatic neoplasms. Bone scanning with ^{47}Ca or ^{85}Sr for the diagnosis of bone neoplasms was compared with radiographic methods.

Bone lesions were detected by scanning 34 to 146 days prior to their appearance on radiographs. The effects of external irradiation (870 to 2980 rads of 15 MeV electrons) on mineral metabolism in the bones of adult dogs were studied using ^{47}Ca or ^{85}Sr as tracers. The kinetics of Ca metabolism in normal man and in patients with hypercalcemia induced by cancer or with hyperthyroidism were studied using ^{47}Ca or ^{85}Sr as tracers and radioassay of blood serum or excreta or whole-body counting. Selenium-75-selenomethionine was a useful agent for the preoperative localization of hyperfunctioning parathyroid tissue by scanning. (C.H.)

12149 (NYO-910-75, pp 46-84) CYCLOTRON FACILITY AND RADIONUCLIDE PRODUCTION. Laughlin, John S.; Tilbury, Roy S.; Mamacos, James P. (Sloan-Kettering Inst. for Cancer Research, New York).

The design and testing of beam characteristics of a small fixed-energy cyclotron are described. Particle energy and external beam current measurements for protons, deuterons, and ^{3}He are reported. Data on the yields of ^{121}I, ^{123}I, and ^{124}I from the reactions of ^{3}He particles with Sb and the yield of ^{52}Fe from the bombardment of Cr with α particles are included. Use of the facility for production of sterile pyrogen-free radiopharmaceuticals and radioactive gases ($^{15}O_2$, $C^{15}O$, $C^{15}O_2$, $^{13}N_2$, and $^{11}CO_2$) for human use is discussed. (C.H.)

12150 (TT-67-56003/5) POLISH REVIEW OF RADIOLOGY AND NUCLEAR MEDICINE. Translation of Polski Przegl. Radiol. Med. Nukl., 31: No. 5, 623-728(1967). 117p. CFSTI.

Separate abstracts were prepared on two of the 15 papers presented in this review. The other 13 papers deal with routine radiographic or tracer studies in medicine. (E.R.B.)

For abstracts of individual papers see: 12000 and 12151.

12151 (TT-67-56003/5, pp 725-9) NEW SYSTEM OF RAPID MANUAL PROCESSING OF ROENTGEN FILMS. Eberhardt, Roman. Translated from Polski Przegl. Radiol. Med. Nukl., 31: No. 5(1967).

A rapid method for processing roentgen films manually in the darkroom is described. (auth)

12152 MEASUREMENT OF ECF USING RADIOACTIVE SODIUM SULFATE AND ITS CLINICAL APPLICATION. APPLIED TO PATIENTS WITH GASTROINTESTINAL MALIGNANCY. Kataoka, Ikuko (Tokyo Univ.); Albert, S. N. Masui, 16: 692-8 (Sept. 1967).

Extracellular fluid (ECF) was determined using dilution technique of the radioactive sodium sulfate. A new type of anthracene free-flow cell was applied to determine the β-ray emitting ^{35}S. This technique was proved to be reliable when checked with a liquid scintillation counter and was considered to be superior to the other in its economy and technical ease. A group of patients with malignancies of the gastrointestinal tract were chosen as a clinical sample. ECF values of this group were not different from those of healthy volunteers or of patients with other types of disease. (NSA of Japan)

12153 THE STATE OF DEVELOPMENTS IN UTILIZATION OF RADIOISOTOPES AND RADIATIONS IN JAPAN, AND THE PROBLEMS. Saito, Minoru; Suto, Mitsuo (Japan Atomic Industrial Forum, Inc., Tokyo). Genshiryoku Chosa Jiho, No. 14, 38-54(Dec. 1967). (In Japanese).

Radioisotopes and radiations are widely used in Japan in medicine, agriculture, industries, etc., for the purposes of research, production, and social welfare. The state of development and problems in this field are described in the following: the status of radioisotopes and radiations in atomic energy; utilization of radioisotopes and radiations, especially in industry; the long range outlook for their utilization; and measures for promotion of their development and utilization and associated problems. (NSA of Japan)

12154 LIVER SCANNING FOR DETECTION OF COLLATERAL CIRCULATION IN LIVER DISEASE. Johnson, Raymond B. (Naval Hospital, Bethesda, M. D.); Castell, Donald O.; Lukash, William M. J. Amer. Med. Ass., 207: 528-32(Jan. 20, 1969).

To determine whether the liver-scan findings previously shown to be related to portal-systemic collateral circulation occur only in patients with fibrotic liver disease, 567 hepatic scans with gold ^{198}Au performed over a six-year period were reviewed. Observance for liver mottling, splenic uptake, or bone-marrow uptake of the isotope showed that one or more of these abnormalities was present in 51 (9.0%) of the patients. Evidence of portal-systemic collateral circulation on scan was most prominent in hepatic cirrhosis (76.6%); extrahepatic malignancies, acute and chronic hepatitis, hereditary hemorrhagic telangiectasia, and chronic lung disease accounted for the remainder. Evidence of portal-systemic shunting was most common in cirrhosis, and, when seen in the noncirrhotic patient, occurred when portal hypertension and hepatic collateral circulation were likely to be present. (auth)

12155 ESTHESIONEUROBLASTOMAS. A REPORT OF 7 CASES. Castro, Leonidas; de la Pava, Samuel; Webster, John H. (Roswell Park Memorial Inst., Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 7-13(Jan. 1969).

Esthesioneuroblastoma is a rare tumor of nasal-neurogenic origin which, because of its close resemblance to the neuroblastomas arising in the adrenal region, is difficult to diagnose. These tumors tend toward local recurrence rather than hematogenous metastases, although the latter occur in advanced cases. The tumor is quite curable and the treatment of choice is excisional surgery followed by intracavitary Ra or x radiation therapy to total tumor doses of 5,000 to 6,000 rads in 5 to 6 weeks. The literature is reviewed and 7 additional cases are reported in detail, bringing the total to 104 cases in the world literature. (C.H.)

12156 LUNG SCANNING IN PULMONARY EMBOLISM. Spencer, R. (Liverpool Clinic); Seaton, A.; Little, W. A. Brit. J. Radiol., 41: 885-95(Dec. 1968).

Fifty patients with pulmonary embolism diagnosed on clinical grounds were divided into three groups. Lung scans were performed in these patients using macroaggregates of human albumin labeled with ^{131}I or ^{99}Tc. Of ten patients with major embolism, all save one had large and multiple avascular areas. Of 21 patients with small emboli causing infarction, ten had abnormal scans. Of 19 patients with multiple small or atypical emboli, 16 had markedly abnormal scans. Details of the technique, difficulties in interpretation, and the potential value of scans in diagnosis and follow-up studies are discussed. (auth)

12157 MEASUREMENT OF THE UPTAKE OF ^{99m}Tc BY THE THYROID. de Garreta, A. C.; Glass, H. L.; Goolden, A. W. G. (Hammersmith Hospital, London). Brit. J. Radiol., 41: 896-8 (Dec. 1968).

The uptake of ^{99m}Tc by the thyroid was measured in a group of normal subjects and in patients with various thyroid disorders. ^{99m}Tc gives a very low radiation dose to the thyroid but apart from this it does not seem to have any great advantage compared with radioactive iodine for the routine assessment of thyroid function. Its potential advantage in the assessment of thyroid function in patients being treated with an antithyroid drug is discussed. (auth)

12158 METHODS OF IRRADIATION OF THE PELVIS BY EXTERNAL AND INTRACAVITARY IRRADIATION IN THE TREATMENT OF CARCINOMA OF THE UTERINE CERVIX: A COMPARISON OF EARLY RESULTS WITH PARTICULAR REFERENCE TO MORBIDITY. Adler, G. F. (Peter MacCallum Clinic, Melbourne). Australas. Radiol., 12: 378-83(Nov. 1968).

The problem of treatment of carcinomas of the cervix by a combination of external and intracavitary methods of irradiation is discussed. A retrospective survey of 200 consecutive cases seen in the years 1964 and 1965 is presented. Intracavitary application of radium, radon, or ^{60}Co and external β, γ, or x radiotherapy were used. The results of treatment by each method are compared by tabling complications seen during the first two years following treatment. The relative advantages and disadvantages of intracavitary and external methods of irradiation are discussed, and the place of preoperative intracavitary radiation therapy is reviewed. The method of combined external and intracavitary irradiation at high dosage produced more frequent complications than did the conventional forms of treatment. It is suggested that greater risks may have to be accepted if effective treatment is to be given to patients with advanced tumors which prove to be unsuitable for initial treatment with intracavitary radon. (auth) (TSS)

12159 TWO ROLES OF THE SCAN IN THE DIAGNOSIS OF CEREBRAL TUMOURS. Sephton, R. G. (Cancer Inst., Melbourne); Morley, J. Barrie. Australas. Radiol., 12: 328-43(Nov. 1968).

The cerebral scan using ^{99}Tc has a clearly established role as a routine, or screening, investigation procedure in the diagnosis of cerebral tumors. In addition, it often provides significant assistance in special diagnostic problems in which neuroradiology has not been helpful. This latter point should be adequately weighted in the overall assessment of the role of cerebral scanning. (auth)(TSS)

12160 CANCER OF THE BASE OF THE TONGUE. 116 PATIENTS TREATED RADIOTHERAPEUTICALLY IN THE 11 YEAR PERIOD 1952 THROUGH 1962. Scanlon, Paul W.; Soule, Edward H.; Devine, Kenneth D.; McBean, James B. (Mayo Clinic, Rochester, Minn.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 26-36(Jan. 1969).

Data on 116 patients with cancer of the base of the tongue treated in the years 1952 through 1962 are reviewed. Broad treatment categories consisted of: (1) 68 patients given continuous conventional radiotherapy with a 5 year survival rate of 29 per cent; (2) 34 patients treated by split-dose methods with a 5 year survival rate of 32 per cent; and (3) 14 patients treated by miscellaneous methods such as cautery excision and implantation of radon seeds with or without supplemental radical lymph node dissection, with a 5 year survival rate of 29 per cent. No improvement in treatment effectiveness could be ascertained from either a change to supervoltage or ^{60}Co teletherapy methods in 1954 or a change to split-dose methods in 1958. An apparent dose-dependency, however, was noted: patients receiving suboptimal dose levels (below 5000 R) had a 5 year survival rate of 19 per cent in contrast to 34 per cent with dose levels above this amount. An apparently increased incidence of second unrelated cancers appearing after treatment of the cancer of the base of the tongue was noted, 15 per cent of the series developing such additional neoplasms. Seven per cent of the series had fatal complications following radiotherapy; these included radiation myelitis, local fatal radionecrosis, and exsanguinating post-treatment hemorrhage. (C.H.)

12161 TWENTY YEARS' EXPERIENCE WITH RADIATION THERAPY OF MEDULLOBLASTOMA. **Aron, Bernard S. (State Univ. of New York, Brooklyn). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 37-42(Jan. 1969).**

Twenty-four patients with medulloblastoma were examined from 1946 to 1966. This tumor was more frequent in children (17 patients) than in adults (7 patients). The age range was 5 months to 83 years. There was a male predominance in the series (15 males to 9 females). These tumors are usually located in the cerebellum (23 out of 24 cases) and the patients presented with cerebellar symptoms (usually ataxia), as well as symptoms of increased intracranial pressure (headache and vomiting). No patients survived who were untreated or treated by surgery alone. The survival for untreated children was 5 months; the average length of time of symptoms in all the children was 4 months. Five out of 15 patients treated by γ or x radiation therapy and surgery are alive. When the tumor recurred after treatment, it was usually in the cerebellum. There was no difference in results with either fractionated doses of 2500 R to 3000 R in 4 to 9 weeks or doses of 4000 R in 4 to 6 weeks. There was a significant difference in results in patients who had adequate treatment coverage of the skull (5 out of 7 alive) as against inadequate field arrangement (none out of 8 alive); 1 patient developed convulsions following radiation therapy and died 5 years and 6 months after treatment. Modified life table study suggests a 5 year survival of 35 per cent and a 10 year survival of 26 per cent after radiation therapy. (auth)

12162 THE TREATMENT AND PROGNOSIS OF MEDULLOBLASTOMA IN CHILDREN. A STUDY OF 82 VERIFIED CASES. **Bloom, H. J. G.; Wallace, E. N. K.; Henk, J. M. (Royal Marsden Hospital, London). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 43-62(Jan. 1969).**

A study was made of 82 histologically verified cases of medulloblastoma under 15 years of age. The treatment used for medulloblastoma consisted of surgical exploration with removal of as much of the tumor as possible without increasing unduly the operative risk. This must be followed by irradiation of the entire cerebrospinal axis. At present, a maximum dose to the cerebellum and brain-stem of 4,000 to 4,500 R in 6 to 7 weeks is recommended for children under 3 years, and 4,500 to 5,000 R in 6 to 7 weeks for older children. The prophylactic dose to the remainder of the brain falls from 4,000 R in the middle region to 3,000 R at the frontal poles. The spinal cord receives 2,000 to 2,500 R. The cases reported here have been treated with 250 kV x rays. Megavoltage equipment (6 MeV) was used for older children. Of 68 unselected cases followed for 5 years, 22 (32%) survived, and of 34 cases, 9 (26%) were alive at 10 years. (C.H.)

12163 MANAGEMENT OF CERVICAL LYMPH NODE METASTASIS BY MEGAVOLTAGE RADIOTHERAPY. **Hanks, G. E.; Bagshaw, M. A.; Kaplan, H. S. (Stanford Univ., Palo Alto, Calif.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 74-82 (Jan. 1969).**

Neoplasm recurrent within the irradiated volume was seen in only 4 of 15 patients with carcinoma of the nasopharynx metastatic to the cervical lymph nodes after treatment of both the primary neoplasm and the cervical metastases by megavoltage x radiotherapy. Nineteen of 69 patients with various other primary head and neck cancers associated with N-2 or N-3 clinical lymphadenopathy were free of tumor for 2 years or more (5 year survival rate 26%) after treatment by radiotherapy alone. Treatment failed in only 2/69 patients (3%) because of inability to sterilize lymph node metastases when the primary neoplasm was controlled. (auth)

12164 DEFINITIVE RADIOTHERAPY OF PRIMARY MEDIASTINAL SEMINOMA. **Bagshaw, Malcolm A.; McLaughlin, William T.; Earle, John D. (Stanford Univ., Palo Alto, Calif.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 86-94(Jan. 1969).**

Primary mediastinal seminoma, although of obscure origin, appears to be a distinctive clinical entity. It is infrequently cured by resection only. Like seminoma testis, it is both radiosensitive and radiocurable. Lymphangiography should be employed for evaluation of possible paraaortic metastases. Whether or not totally resected, the mediastinum and supraclavicular lymph nodes should be irradiated en bloc. A tumor dose of 4000 to 4500 rads x radiation in 4 weeks appeared to be adequate. Subsequent metastases, though multiple, should be vigorously pursued and irradiated to the same tumor dose. (auth)

12165 ENHANCEMENT OF X-RAY EFFECTS ON THE SMALL INTESTINAL EPITHELIUM OF DOGS BY ACTINOMYCIN D. **Concannon, Joseph P.; Summers, Roy E.; King, John; Tcherkow, George; Cole, Christine; Rogow, Edward (Allegheny General Hospital, Pittsburgh). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 126-36(Jan. 1969).**

The combination of Actinomycin D and x irradiation of the upper portion of the abdomen of dogs, in doses which, by themselves, produce no significant clinical, histologic or biochemical abnormalities, resulted in the death of 9 of 12 animals scheduled to receive between 1900 and 3100 R. The actual radiation doses received by these animals were lower than those scheduled (1424 to 2583 R) since many animals died prior to completion of the proposed radiation dose. The cause of death was undoubtedly related to the severe changes produced in the epithelium of the small intestine following the combined treatment of Actinomycin D and x radiation. Marked depression of serum chlorides was observed in more than half of the animals in the group which received Actinomycin D and x radiation. Hyponatremia was observed in only a few animals in the combined treatment groups. The elevation of serum phosphorus observed in many of the animals in the various treatment groups appeared to be related to the administration of Actinomycin D rather than to the effects of the combined treatment. Bone marrow depression and the depression in lymphocytes observed in this investigation also appeared to be related primarily to the use of the drug. Mechanisms of action for the enhanced response of the small intestinal epithelium to x radiation and Actinomycin D treatment are postulated. The appearance of severe gastrointestinal symptoms in patients receiving combined Actinomycin D and x radiation treatment to the abdomen should be an indication for immediate interruption of treatment. (auth)

12166 PERMANENT INTERSTITIAL THERAPY USING LOW ENERGY AND LONG HALF-LIFE RADIATION SOURCES. **Scallon, Joseph E.; Sondhaus, Charles A.; Snyder, Samuel L.; Feder, Bernard H.; Gunn, Walter G. (Univ. of California, Los Angeles). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 157-64 (Jan. 1969).**

Eight patients with head and neck carcinoma were treated using permanent interstitial implants of radioactive ^{125}I seeds. A marked decrease in radiation exposure to the medical personnel was achieved. The monitoring of the patients following surgery revealed that they emitted acceptably low levels of radiation for their out-patient status. Reactions to date differ depending upon the area implanted, although all show a slow buildup of maximum reaction. There is a paucity of reparative process seen in those cases where the palate was implanted. Close follow-up of these patients will be continued and, if possible, microscopic sections of the implanted tissue will be obtained. (auth)

12167 CURRENT TECHNIQUES WITH 6 TO 18 MeV ELECTRON BEAM. **Tapley, Norah duV.; Fletcher, Gilbert H. (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 172-7(Jan. 1969).**

Current techniques using electron beam for the therapeutic treatment of primary lesions of the upper respiratory and digestive passages, treatment of cervical lymph node metastases, and treatment of breast cancer following radical mastectomy are described. Interstitial radium and cobalt-60 γ were used to complete the treatment in some cases. (C.H.)

12168 RADIATION NEPHRITIS. **Van Slyck, Ellis J.; Bermudez, Gustavo A. (Henry Ford Hospital, Detroit). Yale J. Biol. Med., 41: 243-56(Dec. 1968).**

Two patients with chronic radiation nephritis following radiotherapy, one of whom died of renal failure and hypertension, are reported. Anemia in this disease is usually more severe than in other forms of chronic nephritis, and has multiple causes. Ferrokinetics and plasma erythropoietin assay indicated an erythropoietic depression. The associated radiation of vertebral and pelvic marrow contributes an additional effect not seen in other types of renal failure. Recognition of radiation nephritis is important because of the possible benefit from cortico-steroid therapy in the evolutional stage, and because removal of a unilaterally damaged kidney may cure the associated hypertension. Better prophylactic techniques for protection of the kidney are under investigation, and may eventually reduce the incidence and severity of this iatrogenic disorder. (auth)

12169 TECHNIQUE OF LARGE-FIELD X-RAY THERAPY OF PATIENTS DURING THE OPERATION. Shevchenko, I. T.; Khmelevskaya, V. N.; Nekrasov, P. Ya. (Scientific-Research Inst. of Roentgen-Radiology and Oncology, Kiev). Med. Radiol., 14: No. 1, 11-15(Jan. 1969). (In Russian).

This method of operation using large-field radiation obviates certain technical difficulties and is conducive to an equal penetration of the radiation dose into the wound and on the surface. It also shortens the period of irradiation on the operating table. In large-field radiations a number of patients needs neither a preoperative nor postoperative course of external teleirradiation and that lessens considerably the general radiation load on the patient. The method of operative radiation in 57 patients suffering from malignant tumors was approbated in the clinic. (auth)

12170 METHOD OF STERILIZATION OF CLOSED RADIOACTIVE ISOTOPES. Yakhontov, N. E.; Abelevich, I. G. Med. Radiol., 14: No. 1, 58-61(Jan. 1969). (In Russian).

A new method for sterilization of closed radioisotopes is proposed. For this purpose cetylpyridinium chloride was used in a dilution of 1 : 5000. This preparation ensured a 100 per cent sterilization of closed radioisotopes when immersed in the solution for one minute. Studies of the reaction in animals, histologic preparations at different terms after administration of the substance, showed its nontoxicity and absence of morphological changes. Radiological clinic studies of cetylpyridinium chloride demonstrated its effectiveness and absence of any complications in patients. (auth)

12171 EXPERIENCE IN OPERATING A LINEAR ACCELERATOR OF ELECTRONS WITH AN ENERGY OF 5 MeV. Pavlov, A. S.; Kvasov, V. A. Med. Radiol., 14: No. 1, 32-8(Jan. 1969). (In Russian).

The design and dosimetric characteristics of a therapeutic linear accelerator with an energy of 5 MeV is described. The accelerator works in a bremsstrahlung regimen. The first clinical results of treating malignant neoplasms of diverse localization are reported. (auth)

12172 THE CALCULATION ON THE DOSAGE OF PREPARATIONS REDUCING THE DEPOSITION OF ^{90}Sr IN THE ORGANISM. Dubrovina, Z. V.; Dolmatova, M. Yu.; Malkin, P. M.; Nesterenko, V. P. Med. Radiol., 14: No. 1, 28-31(Jan. 1969). (In Russian).

In experiments on rats, the protective effects of different preparations against ^{90}Sr was studied: alginic acid, sodium alginate, ammonium oxalate and sodium phytate. It was found that in first approximation the optimally effective dose of the substance may be calculated by its equivalent weight and content of calcium in the ration. For all four substances studied this dose corresponded to the ratio—1 gm/equivalence of Ca to 3 to 4 gm/equivalence of protective preparation. (auth)

12173 ^{51}Cr-DTPA IN RENAL DIAGNOSIS. Deckart, H.; Flentje, H.; Herzmann, H. (Nuklearmedizinische Abteilung der Radiologischen Klinik, Berlin. Institut fuer Angewandte Isotopenforschung, Berlin). Nucl.-Med., 7: 205-11(Oct. 31, 1968). (In German).

The chelate-forming diethylenepentaminoacetic acid (DTPA) was labeled with ^{51}Cr. Clearance studies demonstrated that the complex, like ^{51}Cr-EDTA, is excreted by the kidneys by means of glomerular filtration. Results obtained indicate that its diagnostic use is similar to that of ^{51}Cr-EDTA. (auth)

12174 RADIOISOTOPE RENOGRAPHY DURING FUROSEMIDE (LASIX) DIURESIS. Rado, J. P.; Banos, Cs.; Tako, J. (Janos Hospital, Budapest). Nucl.-Med., 7: 212-21(Oct. 31, 1968).

In 20 selected patients, isotope renography was done in dehydration and during diuresis induced by the administration of furosemide (Lasix). In 19 patients a significant disparity between the tracings of the two kidneys was found in the dehydration renogram. The disparity disappeared during furosemide diuresis in patients with mild ureteropelvic obstruction, different forms of hypertension, pyelonephritis but without substantial loss of functioning renal mass. In five cases in which intravenous pyelography demonstrated significant differences in size between the two kidneys, the disparity between the tracings in the control renogram did not change substantially during furosemide diuresis. Furosemide diuresis seemed to be helpful in the evaluation of apparently abnormal renograms. The furosemide renogram may, in selected patients, be advantageous in isotope renography involving high diuresis. (auth)

12175 INFLUENCE OF AORTOGRAPHY ON THE RADIOISOTOPE RENOGRAM. Malamos, B.; Christeas, N.; Gyftaki, E.; Balas, P.; Alevizou-Terzaki, V. (Univ. of Athens). Nucl.-Med., 7: 222-30(Oct. 31, 1968).

This study concerns the influence of translumbar aortography on the radioisotope renogram. A correlation was made between the renogram tracings before and after aortography. Translumbar aortography affects radioisotope renogram tracings if the tracings are normal before aortography, in 31.5% of the studied cases. No correlation was found between the abnormal post-aortographic renogram tracings and the time elapsed from the aortography during the first week, the level of injection or the amount of the injected dye. It is recommended that the radioisotope renogram should be performed seven days after aortography for obtaining reliable tracings. (auth)

12176 ^{99m}Tc IN THYROID SCINTIGRAPHY. Umek, H.; Czembirek, H. (Medical Univ., Vienna). Nucl.-Med., 7: 231-9(Oct. 31, 1968). (In German).

Studies in over 100 patients indicate that ^{99m}Tc-pertechnetate is, for several reasons, superior to ^{131}I in scintigraphic studies of the thyroid. It should definitely be used in juvenile patients and in patients receiving thyroid hormones. The problems arising from the simultaneous concentration in the gastrointestinal mucosa and in the salivary glands are discussed. The possibility of increasing the excretion of this radionuclide by oral administration of perchlorate is mentioned. (auth)

12177 SIGNIFICANCE OF THE HORMONAL ACTIVITY OF PARATHYROID ADENOMATA FOR SCINTIGRAPHY WITH ^{75}Se-SELENOMETHIONINE. Haubold, U.; Frey, K. W.; Karl, H. J. (Univ., Munich). Nucl.-Med., 7: 240-50(Oct. 31, 1968). (In German).

In 10 patients with primary hyperparathyroidism, scintigraphy with ^{75}Se-selenomethionine was done before surgery. In 6 patients the positive scintigraphic findings were confirmed surgically. In 2 patients additional tumors were not visualized. The capability of the scintigram to visualize parathyroid adenomata is primarily determined by their hormonal activity. Adenomata with low endocrine activity cannot be seen in the selenomethionine scintigram. In this series confirmed parathyroid adenomata were not visualized when the serum calcium concentration was below 5.8 mVal/l. A review of the published cases of other authors indicates a similarly high limit. In view of these findings, the value of parathyroid scintigraphy appears to be limited. The application of this technique is only justified by the fact that in contrast to the radiological methods it is without risk to the patient but has a similar diagnostic accuracy. In patients with negative scintigrams additional radiological visualization should be attempted. (auth)

12178 DEMONSTRATION OF SPACE-OCCUPYING LESIONS IN THE SPINAL CANAL BY MYELOSCINTIGRAPHY WITH ^{99m}Tc-PERTECHNETATE. Akhtar, M.; Winkler, C.; Betz, H. (Univ., Bonn.) Nucl.-Med., 7: 251-6(Oct. 31, 1968). (In German).

A method of scintigraphic demonstration of space-occupying lesions in the region of the spinal canal is described. In contrast to techniques used hitherto, the test substance is ^{99m}Tc in the form of pertechnetate, so that the myeloscintigraphy can be performed without hazards. Very valuable diagnostic results are obtained in a relatively short period of time. (auth)

12179 RADONOVYE VODY I IKH LECHEBNOE PRIMENENIE. (Radon Waters and Their Therapeutic Properties). Smirnov-Kamenskii, E. A.; Petelin, S. M. Biblioteka Prakticheskogo Vracha. Moscow, Izdatel'stvo Meditsina, 1966. 216p.

Basic data are given on radioactive decay and ionizing radiation in radon waters. A list of health resources using therapeutic properties of radon-containing waters are described. Dosimetry and alpha-therapy doses, effects, and preparation, and uses of artificial radon waters are evaluated. (R.V.J.)

12180 MEDICAL CARE OF WORKERS SUBJECTED TO IONIZING RADIATION. Jammet, H. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). pp 511-16 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Radiological protection depends essentially on the prevention and the control of radiological nuisances by the appropriate technological procedures and dosimetric methods. The medical procedure has the purpose of controlling the health of workers exposed to ionizing radiation and to assure the necessary care for irradiated and contaminated workers. The medical control of the health of the workers is not competitive but complementary to the physical control of ionizing radiations. It aspires first to determine the medical facilities of the work post considered, then to verify the preservation of a satisfactory state of health during work, and finally to make decisions imposed either in the case of exposure to radiation or in the case of illness. The doctor puts in operation the classical methods of examination for the general clinical examination and special methods for the particular examinations of organs and functions the most sensitive to radiological effects such as the hematopoietic system, skin, eyes, etc. The medical care dispensed to irradiated or contaminated personnel during radiation accidents necessitates a triple action in the complementary regions of dosimetry, diagnosis, and treatment. The first consists in the collection of all useful data on the precise circumstances of the accident, the nature and importance of the irradiation or the contamination; it imposes the evaluation of external doses received or of internal contaminations incorporated; it often necessitates the reconstruction of the accident in order to make more precise these data. The second seeks to collect all data relevant to the injury to the organs and the function most exposed which are, according to the case, the skin, bone marrow, intestine, lungs, liver, and kidneys; the diagnosis should be, if possible, not only qualitative but quantitative and correlated with the dosimetric data. The third consists in putting into operation the appropriate treatments on the basis of the therapeutic indications established from dosimetric and clinical data; in the case of partial or total external irradiation it necessitates starting procedures fighting the infection, hemorrhage, and tissue degradation; in the case of contamination it causes the use of methods of external or internal decontamination. These medical procedures can be accomplished in a correct and efficient fashion only by an adequate organization; on the work sites, doctors should arrange infirmaries permitting necessary investigations and assuring the primary care; in the hospitals, only specialized equipment, assembling the complete range of competences and having available convenient means of isolation and decontamination, can offer a certain efficiency for taking in charge and treating irradiated and contaminated personnel. (tr-auth)

12181 EFFECTS OF CALLICREIN ON RADIATION LESIONS. Simon, S. (Univ., Brussels); Rodesch, J. pp 205-7 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The de-insulinized pancreatic extracts (callicrein or padutine deposit) have a scarring trophic action on acute and chronic radiolesions. A study on animals shows that the radionecroses heal better and more rapidly. A cure is obtained following doses causing in subjects a stable ulceration. In man, the treatment of accidental or therapeutic radiolesions was studied in 127 cases with 80% good results. The marked reduction or disappearance of the lesion is rapid. The extreme diversity of the radiolesions controls the therapeutic plan or the duration of treatment for each particular case. Positive results were obtained in acute and chronic skin radionecroses; radionecroses of the cervix, bladder, mucous membrane, and bone; radiomyosites; and delays of scarring. (tr-auth)

Radiation Effects on Animals

12182 (AEC-tr-6871/5) UKRAINIAN JOURNAL OF BIOCHEMISTRY. Translation of Ukr. Biokhim. Zh., 39: 460-565 (1967). 127p. (TT-68-50323/5; IPST-Cat.-5121). Dep. CFSTI.

Papers within the scope of NSA were abstracted from the original language and appeared in previous issues. (C.O.)

12183 (AEC-tr-6915) RADIOBIOLOGY. Translation of Radiobiologiya, 8: 179-328(1968). 265p. Dep. CFSTI.

Papers within the scope of NSA were abstracted from the original language and appeared in previous issues. (C.O.)

12184 (AEC-tr-6916) RADIOBIOLOGY. Translation of Radiobiologiya, 8: No. 3, 339-477(1968). 207p. Dep. CFSTI.

Papers within the scope of NSA were abstracted from the original language and appeared in previous issues. (C.O.)

12185 EFFECTS OF ULTRAVIOLET LIGHT ON MAMMALIAN PIGMENT CELLS IN VITRO. Kitano, Yukio; Hu, Funan (Oregon Regional Primate Research Center, Beaverton). J. Invest. Dermatol., 52: 25-31(Jan. 1969).

Results showed that 1 second of uv irradiation inhibited cell proliferation and decreased mitotic activity, but did not affect DNA synthesis. The delayed appearance of labeled mitoses after irradiation suggested that the main effect of uv on the cell cycle is to prolong the G_2 period. Longer exposures, e.g. 5 seconds, however, resulted in an almost complete and irreversible cessation of proliferation. Five-second exposures also inhibited DNA synthesis, but not until 8 hours after irradiation, and became more apparent at later hours. The direct effect of uv on pigment cells in culture was to inhibit proliferation but not to stimulate melanin synthesis. This differed from the response of the epidermal melanocytes in vivo. It must be remembered that in vivo, melanocytes exist in the epidermis together with keratinocytes in an apparent system that has been called epidermal melanin unit. The absence of keratinocytes in cultures could explain at least in part the lack of pigmentary response of the melanocytes. It is possible that extra-melanocytic factors (epidermal or dermal) are necessary to induce increased pigmentation. Multiple exposures of uv irradiation had no effect on the melanin pigmentation in these cells. Exposure of both nonpigmented and pigmented colonies to high doses of uv demonstrated the protective action of melanin pigment against uv. With 20-second exposure, the nonpigmented colonies were completely destroyed whereas the pigmented colonies remained unaffected. This provided clear evidence that melanin granules protect cells against the damaging effects of uv light. (C.O.)

12186 INJURY AND RESTORATION IN RADIATION EFFECT. Streltsova, V. N. Med. Radiol., 14: No. 1, 68-85(Jan. 1969). (In Russian).

The nature of injury and restorative processes in physiological and postradiation regeneration is discussed. It is shown that the qualitative aspect of restorative reactions remains the same in conditions of physiological regeneration and in conditions of restoration of irradiated tissues. In intensively irradiated tissues, a greater role is played by the formation of polyploid cells in the restoration of cellular population than in conditions of physiological regeneration. In contrast to physiological regeneration restoration is incomplete in the irradiated tissues. The level of the irreversible component depends primarily upon the dose of radiation. (auth)(C.O.)

Invertebrates

Refer also to abstracts 11871 and 12050.

12187 (PRNC-122) RADIATION-INDUCED STERILITY FOR POPULATION CONTROL OF THE SUGARCANE BORER (DIATRAEA SACCHARALIS) IN PUERTO RICO. Technical Report No. 4, August 1967-September 1968. Walker, David W. (Puerto Rico Nuclear Center, Mayaguez). Sept. 1968. Contract AT(40-1)-1833. 83p. Dep. CFSTI.

Mass-rearing tests on the sugar-cane borer were conducted to determine mineral requirements of the larvae, to improve diet texture, to improve the keeping quality, and to increase survival rate. Three hundred adults per day were produced on the wheat germ diet. A table is presented to show the mineral content of the diet. Supplementary carbohydrate tests showed that survival was less in carbohydrate-supplemented diets as compared to normal diets. It was concluded that the PRNC diet was not suitable for mass-rearing because it was expensive and survival was low on a routine basis. Fourteen containers were evaluated for their suitability as rearing containers to unfed first-stage larvae. Survival was lower and growth and maturation time were slower in all of the containers in comparison to glass vials. Insects were γ irradiated at a dose rate of 2000 R per minute. Fertilized eggs were killed within 48 hrs after irradiation at 8 Kr or higher. First and second larval instars did not survive to the adult stage when treated with 8 Kr. The third and fourth instars were more radioresistant but net survival was low. Pupae less than three days of age were very radiosensitive; older pupae were less sensitive. Adult males were sterilized by exposure to 26 Kr; life span was not adversely affected by the sterilizing dose. Females were sterilized by doses of 20 to 40 Kr. Host range and host preference studies were conducted using ten species of grasses and other plants; results are tabulated. It was found that corn was the host plant that most nearly satisfied the total requirements of the sugarcane borer. In relative order of general suitability after corn the species can be ranked as follows: teosinte (Euchlaena mexicana), milo (Sorghum vulgare), sugarcane (Saccharum officinarum), and Merker grass (Pennisetum purpurem). (H.L.W.)

12188 EFFECT OF GAMMA-IRRADIATION OF LATE EMBRYO ON THE GROWTH OF SILKGLANDS AND ON SILK PRODUCTION IN THE SILKWORM, BOMBYX MORI. Shigematsu, Hajime; Takeshita, Hiroo. Nippon Sanshigaku Zasshi, 37: No. 2, 88-94(Apr. 1968). (In Japanese).

Silkworm eggs were exposed to ^{60}Co γ rays with total doses of

4000 and 8000 R in the late stage of the embryonic development when differentiation was supposed to be complete. Experiments were carried out during three seasons, that is, spring, summer, and late autumn, and in the experiment performed during the latest season three treatments were added, i.e., 15,000 R irradiation of eggs; and 10,000 and 20,000 R irradiation of newly hatched larvae. Hatchability of eggs was slightly affected by the irradiation. Lethal effects and prolongation of the larval period were observed. While the irradiation by 8000 R caused the retardation of the growth of silk glands, especially of the posterior division, 4000 R did not influence the growth. Females were more affected by γ rays with regard to the weight of silk glands and cocoons. Three characteristic patterns were observed with respect to the growth of silk glands representing spring, summer, and late autumn types. Gamma irradiation resulted in the shift of the patterns from spring to summer or autumn. Although the content of fibroin was markedly decreased, that of sericin was not affected in cocoons produced by silkworms irradiated with 8000 R. Further studies are necessary to clarify the biological effects of radiation. (NSA of Japan)

12189 THE EFFECT OF HYDROSTATIC PRESSURE AND HEAVY WATER UPON REGENERATION IN BLEPHARISMA. Giese, A. C. (Stanford Univ., Calif.). Contract AT(04-3)-326. Exp. Cell Res., 52: 370-8(Oct. 1968).

The effects of hydrostatic pressure and of heavy water on biological activities and regeneration after cutting of *Blepharisma intermedium* were observed with a dissecting microscope. Hydrostatic pressure at 13,000 psi resulted in the disintegration of Blepharisma after 20 min, while at 2,000 psi 50% of the cut Blepharisma regenerated between six and 10 hr, compared to controls at five hr. The addition of heavy water to the medium caused a decrease in the rate of regeneration but the effects of pressure and heavy water were not additive. (C.H.)

12190 EFFECTS OF IONIZING RADIATION ON THREE NEOTROPICAL TERMITE SPECIES. McMahan, Elizabeth A. (Univ. of North Carolina, Chapel Hill). Ann. Entomol. Soc. Amer., 62: 120-5(Jan. 1969).

Adult workers and soldiers of 3 termite species, *Nasutitermes costalis* (Holmgren), *N. nigriceps* (Haldeman) and *Parvitermes discolor* (Banks) from a montane rain forest in Puerto Rico were γ-irradiated with a cobalt-60 source in 2 series of tests. Two dose rates (615 and 42 rad/min) and 3 accumulated doses (3000, 6000, and 12,000 rad) were used. Primary data consisted of LT_{50} values. Significant differences in radiation sensitivity between *N. costalis* and *P. discolor* but not between *N. costalis* and *N. nigriceps* were demonstrated. For all species, workers were more radiosensitive than soldiers. In general, the larger the individual the more radiosensitive it was. Mortality was also positively correlated with dose rate and with dose magnitude, as expected, but interaction between these factors in the experiment complicated some of the interpretations. There is evidence that these rain-forest termites may be more radiosensitive than adult insects have generally been found to be. Such a result might be correlated with the habitual lack of exposure of termites to harsh environmental conditions. (auth)

Vertebrates

Refer also to abstracts 11936, 11937, 11939, 11976, 11988, 11996, 12003–12005, 12014, 12016, 12047, 12049, 12051, 12053, 12054, 12127, 12131, 12135–12139, 12153, 12165, 12168, and 12287.

12191 (AEC-tr-6646/4A, pp 97-102) RECOVERY EFFECT OF HOMOLOGOUS AND HETEROLOGOUS DNA FROM DIFFERENT ORGANS INJECTED INTO TOTAL-BODY IRRADIATED (600 R) INFANTILE MALE RATS AND ADULT MALE MICE. Savkovic, N. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Rats and mice of different ages were exposed to an x-ray dose of 600 R; one half of each group was treated with DNA. Results, presented in the form of graphs, show that in all cases the survival of animals treated with DNA was greater than that of control animals. Results were similar for homologous and heterologous DNA extracted from liver, spleen, and thymus. (H.L.W.)

12192 (BNL-13065) HEAD IRRADIATION AND AGING. Samorajski, T.; Ordy, J. Mark; Zeman, Wolfgang; Curtis, Howard J. (Cleveland Psychiatric Inst., Ohio. Lab of Neurochemistry. Indiana Univ., Indianapolis. Div. of Neuropathology. Brookhaven National Lab., Upton, N. Y.). [1968]. 27p. (CONF-681027-1). Dep. CFSTI.

From Gerontology Society Conference, Denver, Colo.

Morphological, biochemical, and behavioral effects of deuteron irradiation delivered to the dorsal surface of the brain of C57BL/10 female mice at doses of 500 to 50,000 rads are reported. A dose-dependent decrease in longevity of the irradiated mice was observed. The histological and histochemical observations at 10 days and at four and 16 months after irradiation indicated a uniform and dose-dependent destruction of neurons, gliosis, and a reduction in vascular alkaline phosphatase activity. The ultrastructural comparisons between control and 10,000 rad sections revealed the presence of numerous perivascular phagocytes, an increase in the number of fibrils and glycogen granules in reactive astrocytes, and the formation of multilamellar membranes and dense nuclear particles in some cells at 40 and 480 days after exposure of the brain. Deuteron irradiation of the brain also resulted in a significant reduction in brain weight and consequently in total protein, DNA, and RNA content, but not in their concentration. There was a statistically significant change in acetylcholinesterase and serotonin content as well as concentration. From the statistically significant decreases in total protein, DNA, and RNA content and the non-significant changes in concentration and RNA/DNA, protein/DNA, and protein/RNA ratios, it was concluded that deuteron irradiation of the brain resulted primarily in a general loss of cells rather than in specific cytoplasmic changes. Thus, some of the ultrastructural changes observed in cells with the electron microscope following irradiation may represent long-term responses to nuclear damage rather than to direct injury of cytoplasmic protein. It was also concluded that irradiation may have some specific effects on neurotransmitters and related substances such as acetylcholinesterase and serotonin in the brain. The significant behavioral effects observed after deuteron irradiation of the brain may be associated ultimately with some of these biochemical changes. These divergent results suggest that radiation injury leading to life shortening may result from more than one cause. (auth)

12193 (COO-119-237, pp 84-9) SYMPOSIUM ON BONE-SEEKING RADIONUCLIDES. (Utah Univ., Salt Lake City. Radiobiology Div.).

Emphasis in this symposium was on radioinduced cancer. Highlights from 16 of the 28 invited papers are presented. The symposium was supported by the U. S. Atomic Energy Commission and the proceedings are published by the University of Utah Press. (CO)

12194 (COO-119-237, pp 90-100) HEMATOPOIETIC DISORDERS IN BEAGLES INJECTED WITH ^{90}Sr. Dougherty, J. H.; Taylor, G. N. (Utah Univ., Salt Lake City. Radiobiology Div.).

Fatal blood dyscrasia developed in two of 13 beagles injected at about 16 months of age with a single intravenous dose of about 100 μCi ^{90}Sr/kg. Death occurred at 990 and 1285 days post-injection, which is within the range of the latent periods observed for osteosarcoma induction by comparable doses of ^{90}Sr. Erythropoietic failure was the most extreme factor and was the ultimate cause of death. The post mortem changes were characterized by bone marrow hyperplasia, moderate myeloid metaplasia in lymph nodes, spleen, and liver, and severe infarction in one instance. Neoplasia was not observed. (auth)

12195 (JPRS-45483, pp 99-104) RADIOBIOLOGICAL DATA IN RELATION TO LOCAL ASTRONAUT SHIELDING. Grigor'ev, Yu. G.; Nevskaya, G. F.; Abramova, G. M.; Ginzburg, E. V.; Kalandarova, M. P. Translated from Biol. Med., 2: No. 1, 68-72(1968).

In order to determine effectiveness of local shielding of astronauts from the radiations of solar flares, a study of the local protective effectiveness for dogs against 250 MeV proton irradiation at the minimal lethal dose was carried out. The protection was provided by paraffin blocks that screened one-seventh of the body— the head, upper and lower portions of the trunk. The protective effectiveness was evaluated by animal survival, level of radiation sickness, immunobiological reaction, peripheral blood and bone marrow measurements. Control animals exposed to total irradiation perished from acute radiation sickness in an average of 14.5 days. All the test animals survived, head screening giving the best results. The discussion of the mechanisms providing protection of the screened body parts, particularly of the head, includes the role of the bone marrow. (auth)

12196 (NYO-3554-7) EFFECTS OF RADIATION ON MIGRATORY ORIENTATION OF SALAMANDERS. Progress Report, November 16, 1967–November 15, 1968. Shoop, C. Robert (Wellesley Coll., Mass. Dept. of Biological Sciences). Contract AT(30-1)-3554. 34p. Dep. CFSTI.

The effects of x radiation on salamanders (*Ambystoma maculatum*) are summarized. Results of studies of normal migration habits are as follows: Migrating spotted salamanders entered and departed from breeding ponds at or near the same point. This pattern was repeated for three consecutive years. Animals migrating in a meadow to and from the breeding pond often traveled in a corridor 10 to 30 m. wide. Several variations from this plan were noted. Spotted salamanders displaced up to 500 m. may return to the home breeding pond. Migrating adults transferred from the border of one breeding pond to within 10 m. of another breeding pond did not move to the new pond as did controls. Migrating adults transported from the border of one pond to the center of another failed to orient to the old pond or in the direction they were moving when captured. Some adults adopted a new breeding pond when displaced. Animals moved to a laboratory and then released outdoors in an unfamiliar area failed to orient to their pond or in the direction they were moving when originally collected. Handling and laboratory conditions may have altered normal behavior. Since lifelong records of salamander movements are lacking, certainty of navigation ability may be questioned. Sensory bases for orientation remain poorly known. (auth) (CO)

12197 (UCD-472-115) ANNUAL REPORT, FISCAL YEAR 1968. (California Univ., Davis. Radiobiology Lab.). June 1968. Contract AT(04-3)-472. 124p. Dep. CFSTI.

Separate abstracts are included for 28 papers in this report. In addition, there were seven papers not included that cover studies on prenatal ovary development in dogs, thyroid hormone effects on cultured lymphocytes, pulmonary function in dogs, cytogenetics of Marmosa mitis, a lymphocyte culture method, nutrition of marmosa, and a coupler system for magnetic tape output. (C.O.)

For abstracts of individual papers see: 12001–12011, 12051, 12052, and 12198–12212.

12198 (UCD-472-115, pp 2-6) SURVIVAL OF CONTROL AND X-IRRADIATED BEAGLES. Rosenblatt, L. S.; Andersen, A. C.

The study of the effect of x irradiation on survival of female beagles was updated. Survival during the 3 yr immediately after irradiation was inversely related to total x ray dose. All irradiated subgroups evidenced lifespan shortening relative to controls. Lifespan shortening was independent of total elapsed time between first and last exposure for 100 R subgroups but a negative correlation was observed among 300 R subgroups. Gompertz equations of mortality rates fit the data of only the last 6 yr of each irradiation group; during these periods the increase in mortality rates was identical for the three groups. (auth)

12199 (UCD-472-115, pp 7-8) EFFECTS OF WHOLE-BODY X-IRRADIATION ON THE ABILITY OF FEMALE BEAGLES TO REPRODUCE. Andersen, A. C.

The reproductive ability of female beagles exposed as young pups to a single midlethal dose of x rays was impaired but not eliminated. These beagles, up to 6.9 yr of age, weaned an average of 17 pups, 33% fewer than control dams. Fractionated irradiation was used to sterilize female beagles; 26 estrous cycles were exhibited by 7 females, all were infertile. The ovaries at sacrifice revealed no evidence of corpora lutea or corpora albicans. (auth)

12200 (UCD-472-115, pp 21-4) COLONY STATUS AND CLINICAL OBSERVATIONS IN ^{90}Sr AND ^{226}Ra-TREATED BEAGLES. Hosein, Amy; Bulgin, Marie; McKelvie, D. H.

Production of beagles for fulfillment of the experimental design was completed in 1967. Clinical observations probably attributable to irradiation were: leukemias in ^{90}Sr fed dogs; lameness, fractures, dental erosion and discoloration, and ocular lesions in ^{226}Ra treated dogs. Observations not related to irradiation were diarrhea, epilepsy, heartworm incidence, and possible chlordane toxicity. There were 47 preweaning deaths and 21 postweaning deaths for the year. (auth)

12201 (UCD-472-115, pp 31) RADIUM EFFECTS ON TEETH. Bulgin, Marie.

Abnormally colored teeth were observed among the high level radium dogs; the carnassial teeth were most frequently affected. After several months these teeth showed marked erosion. There appeared to be a dose-time relationship. (auth)

12202 (UCD-472-115, pp 32-3) PRELIMINARY OPHTHALMOLOGIC OBSERVATIONS IN THE BEAGLE. Hosein, Amy.

A special study on ocular changes with age in the beagle and one on changes with serial administration of radium, begun at two different ages, were done to provide a basis for evaluation of ^{226}Ra-induced ocular changes. (auth)

12203 (UCD-472-115, pp 34-8) GROSS OPHTHALMOLOGIC OBSERVATIONS OF CONTROL AND ^{226}Ra-EXPOSED BEAGLES. Hosein, Amy.

Gross ophthalmologic examinations were made of control and ^{226}Ra-exposed beagles. Iridic and tapetal alterations, observed in some control dogs, were much more frequent in ^{226}Ra-exposed beagles. Tapetal alterations appeared to precede iridic changes at the higher dose levels; at the lower dose levels, the reverse was true. Alterations appeared earlier in beagles receiving higher dose levels of ^{226}Ra. (auth)

12204 (UCD-472-115, pp 39-44) URINARY HYDROXYPROLINE AS AN INDEX OF BONE METABOLISM IN CONTROL, ^{90}Sr-, AND ^{226}Ra-TREATED BEAGLES. Baggs, R. B.; Della Rosa, R. J.; Rosenblatt, L. S.

Hydroxyproline was measured in the urine of dogs fed ^{90}Sr or injected with ^{226}Ra, and corresponding controls. In controls the total daily excretion of hydroxyproline appears to be highly correlated with nitrogen excretion, and is determined primarily by urine volume rather than hydroxyproline concentration. Stepwise linear regression equations have been developed for normal dogs, allowing evaluation of normalcy of individuals' hydroxyproline excretion. (auth)(C.O.)

12205 (UCD-472-115, pp 50-1) METABOLIC STUDIES OF BONE IN VITRO. Preliminary Report. Baggs, R. B.; Della Rosa, R. J.; Abrahams, C. D.

The rationale and methods for in vitro investigation of bone metabolism are presented. It is suggested that, as ^{90}Sr specific activity is increased, the cell density decreases, but the remaining cells may be more active metabolically. (auth)

12206 (UCD-472-115, pp 52-6) METHOD FOR MICRORADIOGRAPHY OF BONE SAMPLES. McKelvie, D. H.; Coffelt, Shirley; Schwind, John.

To study structural alterations of bone resulting from irradiation from internal emitters such as ^{90}Sr, a microradiography system was developed. The bones are sectioned, polished to 80 μ and stored. Microradiographs are made using emulsion-coated glass slides; the resultant x ray is easily studied microscopically. (auth)

12207 (UCD-472-115, pp 60-2) "PACHYOSTOSIS" RESULTING FROM β-IRRADIATION IN BONE UNIFORMLY LABELED WITH ^{90}Sr. McKelvie, D. H.

A study of microradiographs of bones from dogs uniformly labeled with ^{90}Sr showed an increased percentage of nonactive osteons and decreased percentages of hypomineralized osteons and resorption cavities; medullary indices were lower than controls. Because the resultant bone is more compact, with a smaller medullary cavity, resembling the bones of pachyderms, the condition is termed "pachyostosis." (auth)

12208 (UCD-472-115, pp 63-5) RADIOGRAPHIC CHANGES IN SKELETONS OF BEAGLES ADMINISTERED ^{90}Sr AND ^{226}Ra. Williams, R. Jean Romer; Hanson, R. J.

Pathologic changes in the skeletons of ^{90}Sr- and ^{226}Ra-treated dogs are compared. Only dogs at the highest ^{90}Sr dose level show more than random incidence of injury. A dose-related pattern of injury persists in higher levels of ^{226}Ra-injected dogs up to 4 yr of age. Two dogs at the highest level of radium have developed osteosarcomas; a third dog is believed to have a similar osteosarcoma. (auth)

12209 (UCD-472-115, pp 66-70) BONE-SEEKING RADIONUCLIDE EFFECTS AS DEMONSTRATED BY SCINTILLATION CAMERA SCANNING. Goldman, Marvin; Van Dyke, D. C.

Total body scintillation camera scanning has demonstrated the distribution of ^{90}Sr and ^{226}Ra in Beagles. Scanning of deposition sites of ^{52}Fe and ^{99}Tc indicates no significant changes due to ^{90}Sr treatment. Bone blood flow visualized with ^{18}F indicated no ^{90}Sr effects, but demonstrated ^{226}Ra impairment of the normal pattern and localized an active endosteal resorption site one month before radiographic confirmation. (auth)

12210 (UCD-472-115, pp 71) HEMATOLOGICAL EFFECTS OF RADIUM. Bulgin, Marie.

Immediately after ^{226}Ra injection in dogs, the number of circulating white cells decreases. The count begins to rise after the last injection and approaches control levels. Radium showed a small effect on circulating red cell numbers at the highest dose level; no effect was noted at lower dose levels. (auth)

12211 (UCD-472-115, pp 72-4) MYELOPROLIFERATIVE DISORDERS IN ^{90}Sr-BURDENED BEAGLES. Goldman, M.; Dungworth, D. L.; Wright, J. F.; West, J. E.; Switzer, J. W.; Tesluk, H.

Fourteen Beagles in the two highest ^{90}Sr treatment levels have developed varying degrees of myeloproliferative disorders. The incidence rates range from 2 to 7% per year between 1 and 5 yr of age; the most florid cases of granulocytic leukemia are generally in the younger dogs. Clinically, anemias signal the onset of the disease with variable leukemic response, rare abnormal cells in peripheral blood, and a spectrum of organ infiltration and architectural disruption. The severity of the disease in these cases is correlated with changes in marrow, spleen, liver, lymph nodes, and lung, and other tissues to a lesser degree, consistent with the concept of progressive stages in the development of granulocytic leukemia. (auth)

12212 (UCD-472-115, pp 87-91) RADIOIODINE AND X-IRRADIATION EFFECTS ON BEAGLE PUPS. Bustad, L. K.; Fuller, J. M.

Prior to a long-term program on the effects of various isotopes of radioiodine and x irradiation on the thyroid, a comparative study was performed on the effects of radioiodine with and without whole-body x irradiation. Three sets of three littermate female pups were randomly assigned to three treatment groups: 1500 rads from ^{131}I to the thyroid; 1500 rads ^{131}I + 200 R whole-body x irradiation; and 4500 rads from ^{131}I. The peak thyroidal uptake varied from 9 to 15%, and the pattern of uptake varied considerably, even between littermates. An accurate method was developed for studying thyroidal metabolism of ^{131}I in dogs. (auth)

12213 THE MECHANISM OF THE DELAYED RESPONSE TO X-IRRADIATION OF THE SKIN OF HAIRLESS MICE AND OF RATS. Hurley, J. V.; Ham, Kathryn N.; Ryan, G. B. (Univ. of Melbourne). Pathology, 1: 3-18(Jan. 1969).

The skin of hairless mice and rats was x-irradiated and the pattern and extent of the resulting increase in vascular permeability was followed in cleared preparations after the in vivo injection of colloidal carbon. Above a threshold dosage of approximately 1500 R in mice and 2000 to 2500 R in rats, injury consistently produced increased vascular permeability starting four to five days after irradiation and reaching a maximum about the eighth to tenth day. Leakage was confined to the area of irradiation and occurred both from capillaries and from venules of all sizes. Histological examination showed that the delayed prolonged leakage was accompanied by leukocytic infiltration of the injured area and by damage and necrosis of overlying epidermal cells. Electron microscopic examination revealed alterations in the fine structure of the endothelium of the leaking vessels. These changes were first manifest four to five days after injury and reached full intensity a few days later. The changes were similar in type but less severe than those seen after mild thermal injury to the skin. The findings suggest that the delayed response of skin vessels to x irradiation, like that to mild thermal injury, is due to direct damage to the vascular wall and not to liberation of an endogenous chemical mediator. (auth)

12214 ENHANCEMENT OF RADIATION ACTION BY INHIBITORS-ANTIOXIDANTS. Afanas'ev, G. G.; Pelevina, I. I.; Lipchina, L. P.; Emanuel, N. M. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 3, 333-44(May-June 1968). (In Russian).

The combined action of propylgallate (PG) or ambunol and ionizing radiation on the solid mouse lymphosarcoma NKLy was studied. Multiple intraperitoneal PG injections and subsequent local irradiation of tumors (600 and 300 × 3 R) resulted in enhancement of the lethal action of irradiation and in increase of the number of mice with resolved tumors. The growth rate of unregressed tumors decreased. Thus, there were both sensitive and resistant tumors to the combined action of PG and ionizing radiation. Ambunol administrations did not result in increase of irradiation effectiveness.

12215 EFFECTS OF X RAYS ON THE HEN. Brard, E. (College de France, Paris). Compt. Rend. Soc. Biol., 162: 609-12(1968). (In French).

Hens were exposed to fractionated x-ray doses of 200, 600, and 900 R for total doses of 3000, 3600, and 5200 R. The results showed that the hens had a high resistance to the harmful effects of x radiation, higher than that observed in cocks of the same age. The hens were susceptible to irradiation during the molting season however. The sensitivity to x radiation thus seemed to be connected to a well-defined endocrine state: resistant during laying periods and vulnerable during molting season. (tr-auth)

12216 REPLICA MICROSCOPY AND SCANNING ELECTRON MICROSCOPY OF LASER IMPACTS ON THE SKIN. Goldman, Leon; Vahl, Johanna; Rockwell, R. J. Jr.; Meyer, Robert; Franzen, Marilyn; Owens, Patricia; Hyatt, Susan (Univ. of Cincinnati. Univ., Muenster, Ger.). J. Invest. Dermatol., 52: 18-24(Jan. 1969).

To attempt to define precisely the minimal reactions of the laser on living human skin and the changes about the target areas, various techniques were used. These included skin microscopy of living skin, replica microscopy, light microscopy of fixed tissues, scanning and electron microscopy. Topographical details of living tissue can be observed satisfactorily with skin microscopies up to 50×. More topographic details can be found with replica microscopy and then scanning electron microscopy. The high percentage of artifacts both with replica microscopy and scanning electron microscopy makes interpretation difficult. More studies are needed to improve these techniques for research in topography of the skin at high magnifications. (auth)

12217 SEQUENCE OF CHANGES IN THE FINE STRUCTURE OF THE RETINA OF DOGS IRRADIATED DURING RETINAL MATURATION. Shively, James N.; Phemister, Robert D.; Epling, Glenwood P. (Colorado State Univ., Fort Collins). pp 166-7 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

Beagle dogs were exposed at two days post-partum or 65 days post-breeding (whichever was later) to whole-body doses of x rays (280 KVP) or γ rays (^{60}Co) at doses of 15 to 50% $LD_{50/30}$. Sham-irradiated controls were studied along with the irradiated animals. Two days to several months post-irradiation, eyes were surgically removed from the dogs and sections of the tapetal and nontapetal retina were prepared for electron microscopy. Results indicated that damage to the retina ranged from large areas of necrotic cells at 2 days post-irradiation, through areas of acellularity and axon degeneration at 10 days, to dysplasia of developing photoreceptors and areas showing typical radioinduced rosettes at 30 days. The changes in the retina were bilateral, dose-dependent, and remained in evidence for at least several months. (E.R.B.)

12218 THE EFFECTS OF PARTIAL IRRADIATION ON TAIL REGENERATION IN ADULT SIREDON MEXICANUM. Brunst, V. V. (Roswell Park Memorial Inst., Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 196-206(Jan. 1969).

The tails of 115 adult axolotls (Siredon mexicanum) were amputated, and the regenerates that developed were x irradiated locally 1 to 2 months later with one or another of the following doses: 1000 R, 2000 R, 4500 R, or 6000 R. A more proximal amputation, performed a relatively long time (more than 1 year) after irradiation, was followed by the development of only 12 regenerates, all monstrous. Obviously these regenerates developed from the boundary zone, where irradiation of the cellular material had been only partial. In the other 103 animals, regeneration was completely suppressed. The 12 monstrous regenerates were the products of limited regeneration, and represented various types of abnormalities, ranging from narrow paddle-shaped formations with almost normal axial skeletons and spinal cords to small and narrow awl-shaped formations lacking both axial skeletons and spinal cords. Regression of the axial skeleton, which was observed in previous study in 90% of regenerates of axolotl extremities during the first 100 to 150 days after irradiation, was observed in only one instance in the present study. Pathologic changes in the distal portion of the spinal cord were minor and very similar to such changes in irradiated tails of young axolotls, but ingrowth of the spinal cord in the distal portion of the regenerate did not occur in some cases. (auth)

12219 DEVELOPMENT OF ULTRASTRUCTURAL RADIATION INJURY. Hendee, W. R.; Alders, M. A.; Garciga, C. E. (Univ. of Colorado, Denver). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 147-51(Jan. 1969).

Electron microscopic studies of changes in hepatic parenchymal cells from mice sacrificed 2 minutes after onset of whole-body γ irradiation are described. Some of the changes observed, such as lipid deposition and glycogen depletion, may be related to reduced functional capability of the endoplasmic reticulum. Changes in the rough-surfaced endoplasmic reticulum similar to those occurring immediately after irradiation have not been described during studies of parenchymal cells exposed to other cytotoxic agents. The increased electron density of affected membranes implies the presence of unsaturated lipid, resulting possibly from degradation of the lipoprotein composition of normal reticulum. The rapid occurrence of alterations observed in parenchymal cells suggests a relationship between these changes and biochemical events occurring within the cell during radiation exposure. However, the frequency of occurrence of reticulum alterations decreased rapidly as the radiation dose was lowered below about 1000 rads. (C.H.)

12220 PROBLEM INVOLVED IN THE REACTIVITY OF GLANDULAR PARENCHYMA OF THE ADENOHYPOPHYSIS IN MICE SURVIVING ACUTE RADIATION DISEASE UNDER CONDITIONS OF PARTIAL MARROW SCREENING. Kashchenko, L. A.; Khuseinov, F. (Central Scientific Research Roentgen-Radiological Inst., Leningrad). Dokl. Akad. Nauk SSSR, 183: 960-2(Dec. 1, 1968). (In Russian).

The effects of doses of 750 to 800 R x radiation and of ^{131}I-radioinduced thyroidectomy, or a combination of irradiation and thyroidectomy, on the weight and thyrotropic activity of the pituitary gland were compared in mice. Irradiation was performed with the hind legs shielded. Thyroidectomy caused an increase in the weight of the pituitary and combined thyroidectomy and irradiation caused an initial increase in weight, followed by a decrease that was marked at 90 days following radiation exposure. The secretion of thyrotropic hormones was reduced following irradiation. (R.V.J.)(C.H.)

12221 HYPOXIA PROTECTION AND RECOVERY IN TUMOUR CELLS IRRADIATED AT LOW DOSE-RATES AND ASSESSED IN VIVO. Berry, Roger J. (Churchill Hospital, Oxford). Brit. J. Radiol., 41: 921-6(Dec. 1968).

Murine leukemia cells were maintained in vitro under aerobic conditions for up to 24 hours before assessment of their reproductive capacity in vivo by serial dilution-assay without significantly altering their radiosensitivity. For acute irradiation with x rays delivered in vitro, the oxygen enhancement ratio was 2.5, identical with that for the same cells irradiated and assessed in vivo. There was a slightly greater effect of dose-rate for aerobic cells irradiated at 40 rads/hour than for the same cells irradiated in their hypoxic state in situ; however, this reduced the apparent oxygen enhancement ratio for the protracted irradiation only to 2.2. Implications for the use of high dose-rate intracavitary irradiation in place of protracted irradiation from radium are discussed. (auth)

12222 AFFECTION OF THE BONE MARROW AFTER LOCAL IRRADIATION OF THE TUMOR AND CHRYSOMALLINE ADMINISTRATION. Potapov, S. L. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 14: No. 1, 23-8(Jan. 1969). (In Russian).

In experiments on mice (C57BL × CBA)F_1 with Harding–Passi transplantable melanoma the cellular composition of the bone marrow after the combined effect of x irradiation and chrysomallin on the tumor was studied. In these mice there was seen a potentiation effect on the total quantity of karyocytes. The characteristic for chrysomallin and for the combined action is a significant reduction in the content of cells of the lymphoid and erythroblast series. Changes in the latter at late periods may be the result of destructive processes occurring in the tumor and of neoplastic break-down products on the bone marrow. On the other hand, these alterations may partly be associated with peculiarities in the reactivity and disturbances of regeneration processes in animals with tumors. (auth)

12223 THE EFFECTS OF SPLEEN SHIELDED IRRADIATION ON ^{59}Fe INCORPORATION INTO RED BLOOD CELLS IN THREE DIFFERENT STRAINS OF MICE. Hayakawa, Jun-ichiro; Tsuchiya, Takehiko (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1425-9(Feb. 1968). (In Japanese).

A strain difference in splenic weight response to whole-body x irradiation has been reported previously, i.e., in relatively radiosensitive strains, CF#1/Nrs and RF mice, splenic hyperplasia took place 15 to 20 days after 350 R irradiation, whereas in relatively radioresistant strain C57BL/6, the increase in spleen weight was not remarkable. In order to compare the role of the spleen in erythropoiesis among these strains of mice, the protective effects of spleen shielding on radioiron incorporation into red blood cells were observed in intact (Exp. 1) and preirradiated mice with whole-body 350 R (Exp. 2). Further, a preliminary experiment on mortality for 30 days after 750 R irradiation with the spleen shielding was carried out in these strains of mice (Exp. 3). The spleen and control shielding were performed with a lead sheet, covering externally on the right or the left side of epigastric region. The results obtained were as follows; Exp. 1: the spleen shielding effect in intact mice was the most prominent in CF#1/Nrs strain. Exp. 2: in the preirradiated mice from CF#1/Nrs and RF strain the spleen shielding was more effective than the control shielding, while in the mice from C57BL/6, the effect of the spleen shielding was similar to that of the control shielding, though red cells in this strain took up more radioiron than those in other two strains. Exp. 3: the mortality in the spleen shielded CF#1/Nrs, RF and C57BL/6 mice for thirty days after irradiation were 0, 2.5, and 10%, respectively. From these results it appears that the function of spleen may be genetically contitioned and the protective effect of spleen shielding in irradiated mice may be related to the importance of the spleen in their erythropoiesis. (NSA of Japan)

12224 A MODEL FOR RADIATION INJURY. 8. KINETICS OF ACUTE RADIATION LETHALITY. Sato, Fumiaki (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1442-56(Feb. 1968).

Survival data were obtained on 7,723 fish that received ^{60}Co γ radiation in single or divided exposures. Single doses ranged from 5.4 kR to 104.2 kR and mean survival time ranged from 1.0 to 11.5 days. Death distributions were unimodal in range from 5.4 kR to 75.2 kR and the peak of the distribution shifted gradually to earlier period with dose. A dose of 95.2 kR produced a bimodal pattern in the death distribution. The LD_{50} (1.5 hours) was determined after a conditioning dose of 44.8 kR. This showed that no recovery and no amplification seemed to happen up to the third day. The standard deviation of fluctuation of sensitivity in the population was decreased by the conditioning dose. Per cent residual injury at 48 hours after conditioning dose ranging from 22.7 kR to 62.7 kR was almost independent upon each conditioning dose. An experiment of irradiation of two equal doses in variable time intervals has given some evidence on the additivity of two injuries. A bimodality in the death distribution was seen even in twelve hours of post-irradiation period after single massive exposure. The difference of LD_{50} (α)s between control and preirradiated groups were calculated as a function of the observation period, α. To these data an interpretation was given with an exponential model. (NSA of Japan)

12225 CHANGES OF NERVE FORMATION AND GASTROINTESTINAL MUCOUS MEMBRANE AT REMOTE PERIODS AFTER IRRADIATION. Lebedev, B. I.; Lebedeva, G. A. Med. Radiol., 14: No. 1, 3-6(Jan. 1969). (In Russian).

The state of the gastrointestinal tract and its nervous apparatus was studied in dogs and rats with chronic radiation sickness, induced with ^{90}Sr in a dose of 0.2 to 0.4 μCi/gm and ^{210}Po in a dose of 0.005 μCi/gm during intravenous introduction. At remote periods all the animals developed distinct changes in nerve elements in different areas of intramural plexuses and nerve ganglia, especially after ^{210}Po administration. Changes in the gastrointestinal mucous membrane in these animals testifies to disturbances of the process of physiological and reparative regeneration. Analysis of the data derived suggests dependence between disorders of gastrointestinal regeneration processes and alterations in its nervous apparatus. (auth)

12226 REGENERATION PROCESSES IN THE THYMUS, SPLEEN, AND BONE MARROW OF RATS FOLLOWING WHOLE-BODY X RADIATION WITH DIFFERENT RADIATION DOSES. Boegler, Friedrich (Heiligenberg-Institutes, Ger.); Kriegel, Heinz. pp 209-17 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In German).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

In order to study the reactive, curative, and regenerative processes in the thymus, spleen, and bone marrow after a radiation exposure, rats were whole-body irradiated with doses between 65 and 1000 R. First hourly, and then in daily time spans up to 12 days and more after the exposure, the animals were sacrificed and investigated histologically. Blood and bone marrow smears were made and smear preparations of thymus and spleen were prepared by expanded color methods. Histological sections were also made of the thymus and spleen and over 800 microphotographs of smear preparations were made. Whereas the earlier results of regeneration problems were extensively confirmed, the method of the smear preparations leads to further observations of peculiarities in the tissues following radiation. It was shown that in addition to the dose and time dependent cytological anomalies, simultaneous modifications occur in the vascular tissue functional units and in the fibrous substances of the extracellular space. These modifications are a direct result of the radiation damage and are determinative for the degree of cell deterioration. The degree of damage to the extracellular space is also of significance for the processes of reparation and regeneration. It was possible from the continuing evaluation of the organ smear preparations within the various dose ranges to identify these processes in their morphological multiplicity and their time sequence. These results indicate a super-ordered reaction unit that is thought to represent a typical inflammation phenomenon. (tr-auth)

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Refer also to abstracts 12014, 12054, 12056, 12153, and 12193.

12227 (AEC-tr-6646/4A, pp 73-5) REPAIR OF LETHAL RADIATION DAMAGE IN L CELLS BY DEOXYRIBONUCLEOTIDES, AS RELATED TO CELL CYCLE. Petrovic, D.; Han, A.; Ferle-Vidovic, Ana. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

L cells were synchronized and about 80% were in mitosis. Culture flasks were irradiated hourly with 500 R during the first cell cycle. After irradiation, an equimolar solution of the four deoxyribonucleotides was added to half of the flasks of each lot and all samples were then incubated for two weeks and the colonies counted. The phases of the cell cycle were determined by labeling the synchronized cells for 20 min with tritium-labeled thymidine and the use of autoradiography. A histogram is presented to show the survival of cells irradiated with 500 R at different times after mitosis and the restorative effect of the nucleotides. The cells are about ten times more radioresistant in the G_1 period than in the middle of the S period. The restorative effect of the nucleotides increases toward the S period and remains quite high during the whole of S with a drop in the middle of it. In G_1 there is no restorative effect. (H.L.W.)

12228 (CEA-tr-R-1909) CASE OF RADIATION SICKNESS FROM INTERNAL CONTAMINATION. Safronov, E. I.; Shamov, V. P.; Makykhin, V. M. Translated into French from Med. Radiol., 12: No. 1, 52-62(1967). 26p. (In French). Dep.

A detailed study of a single fatal case of radiation sickness is presented. The patient swallowed 2.03 mCi of ^{226}Ra in November 1960; after a primary general radiation reaction lasting one month the course of the illness became chronic. Against the background of chronic radiation sickness, selective injury to the blood system and skeleton gradually took shape, and signs of neurocirculatory dystonia of the hypotonic type, accompanied by increasing asthenia, were noted, but the most complete, pronounced, and stable changes were in the blood system. The patient's general condition was satisfactory for three years. The changes noted above became increasingly intense between June 1963 and August 1965 when the patient died. The article gives the results of analysis of the patient's blood covering the entire course of the illness, particularly the initial and terminal stages. Measures undertaken to speedily eliminate the radium from the body and the complex therapy of the radiation sickness proved to be of no value. (JPRS)

12229 THE EFFECT OF THE IONIZING RADIATION ON THE DEVELOPMENT OF MALIGNANT DISEASES IN THE CHILDREN. DEGENERATIVE CHANGES IN THE CARPAL BONES OF LEUKEMIC CHILDREN. Gefferth, Karoly. Magy. Radiol., 20: 264-70 (Oct. 1968). (In Hungarian).

The percental incidence of degenerative bone changes in the carpal bones of leukemic children was found to be essentially higher than in other patients. It was concluded that an inferiority of some kind may be present in children susceptible to leukemia, in whom alterations occur in an increased degree and that in such individuals the chances are greater that small mutagen traumata suffered in the fetal age, such as x radiation exposure during radiography, may produce malignant diseases. (auth)(TSS)

12230 XENON: EFFECT ON RADIATION SENSITIVITY OF HeLa CELLS. Schulz, R. J.; Markoe, A. M.; Anigstein, R. (Albert Einstein Coll., New York). Science, 163: 571-2(Feb. 7, 1969).

HeLa cells, plated onto plastic petri dishes, were exposed to various atmospheres composed of air and carbon dioxide; helium, oxygen, and carbon dioxide; and xenon, oxygen, and carbon dioxide in a pressure vessel. Survival curves with x rays, 280 kilovolts (peak), showed that air and helium have the same effect, but that xenon potentiates x-irradiation to the extent that the dose to produce a given level of survival with xenon is 0.58 of the dose required with air. (auth)

12231 INFLUENCE OF RADIUM THERAPY ON MIGRATION OF THE LEUKOCYTES IN THE ORAL CAVITY. Zolotarev, A. E. (Odessa Inst. of Medicine). Med. Radiol., 14: No. 1, 10-11(Jan. 1969). (In Russian).

In 56 patients, with the aid of Yasinovsky's method of consecutive washings, the leukocyte migration in the oral cavity before, during and after a course of x irradiation and ingestion of ^{32}P was investigated. It was found that x irradiation of body areas significantly removed from the oral cavity from the very first session exerted a restricting effect on migration of the leukocytes. X irradiation of areas situated close to the studied mucosa after the first session was attended by an increased intensity of the leukocyte migration, and after consecutive sessions, by its reduction. In most patients (in 9 out of 11) the intensity of migration of the leukocytes increased after one session of x irradiation. A maximal rise was observed in one hour; 24 hours later it reverted to initial or decreased values. Radiophosphorus exerts a restricting effect on the leukocyte migration. (auth) (C.O.)

12232 DETECTION OF RADIATION EXPOSURE BY FLUORESCENT MICROSCOPY OF HUMAN BLOOD CELLS. Vider, E.; Yaari, A.; Shafir, D.; Riklis, E. (Atomic Energy Commission, Beer-Sheba, Israel). pp 525-9 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Changes in blood and bone marrow cells involving effects of irradiation on nucleic acids can be detected by fluorescence microscopy much prior to any morphological changes. When blood smears are stained with acridine orange, the leucocytes appear mostly as doubly colored in a fluorescence microscope, the nucleus being green and the cytoplasm red, yellow or orange. The ratio of doubly colored cells (DCC) to red colored cells is fixed for each subject but decreases following x-irradiation, as found in the following experiments. Persons exposed to x-ray routine radiography of chest, as well as hospital personnel were taken as subjects. X-ray doses were measured with a Victoreen Condenser R-Meter and Victoreen Ionization chambers, as skin doses, and exposure time was 0.05 to 0.1 sec. Blood samples were taken from a finger tip before exposure and at fixed intervals after exposure. Blood smears were prepared and stained with acridine orange in phosphate buffer (5 mg/50 ml or 10 mg%, pH 6.85). Two hundred cells were counted and classified according to color. In all cases the number of doubly colored cells (green and red) before irradiation was above 68%. Following exposure, in most cases the number of DCC decreased while the number of red colored cells increased. The observed changes began 6 hr after exposure, reached a maximum 24 to 48 hr after irradiation and then began to subside. The extent of the effect increased with dose, giving noticeable results already at a dose of 18 milliroentgen. There was a uniform response among persons exposed in the chest, but a smaller change in persons exposed in other organs. Blood smears of technicians and clerks not directly involved in work near the x-ray unit showed no changes in the ratio of DCC to red colored cells. Physicians after fluoroscopy, however, showed a drop in percent of doubly colored cells. Further development of these investigations might lead to a simple method of internal dosimetry for small doses of x rays. (auth)

12233 IMPORTANCE OF THE INCREASE IN THE NUMBER OF BINUCLEATED LYMPHOCYTES FOR DETECTION OF WEAK DOSES OF IONIZING RADIATION. Pendic, B.; Tomin, V. (Boris Kidric Inst. of Nuclear Science, Vinca, Yugoslavia). pp 517-23 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The results obtained during the observation of binucleated lymphocytes (BnL) in the peripheral blood in four groups of individuals exposed to weak doses of ionizing radiations were presented. In the individuals of the first group, where the dose of γ radiation received by the whole body during a single irradiation was of the order of the rad, a statistically significant increase of BnL was established during the second week after irradiation. In the second group where the professional exposure to doses of ionizing radiation remains within tolerable limits, the augmentation of BnL was also established with respect to the control group. In the third and fourth groups where the partial irradiation of the body comes from the diagnostic radioscopy of the lungs and where the x radiation measured in the air at the level of the skin was 2 and 6 R, the increase of BnL was not established. The value of this hematological test for the biodetection of weak doses of ionizing radiation was discussed. (tr-auth)

12234 STUDIES ON VARIATIONS IN BIOCHEMICAL PARAMETERS FOLLOWING IRRADIATION. Marble, G. (CEA, Fontenay-aux-Roses, France). pp 25-32 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

Certain metabolic or functional disturbances caused by radiation in man and higher animals can be taken as evidence for the chemical dosage of blood or urinary catabolites. For evaluating the absorbed dose or biological damage and to prognosticate the chance of survival, the variations in biochemical parameters can be determined experimentally in the animal as a function of time for a given exposure or as a function of exposure at a given moment or during a definite period of time. However, in the case of accidental human irradiation, one knows only rarely the value of biochemical parameters of the accident before irradiation, and it is often difficult to take account of the dispersion of the individual values and to relate the results found to the reference values. It is useful then to study the relative variations in the calculated values as a function of time. Examples and methods of study are given. Analysis of the interpretation of results relative to variations in glycemia and urinary excretion of electrolytes was attempted. (tr-auth)

12235 THE DETERMINATION OF THE BIOLOGICAL EFFECT OF UV RADIATION COMBINED WITH HIGH ILLUMINATION INTENSITY. Muench, W.; Schroeder, G. pp 313-28 of Technisch-Wissenschaftliche Abhandlungen der Osram-Gesellschaft. Band 9. Lompe, Arved (ed.). Berlin, Springer-Verlag, 1967. (In German).

The requirement for the application of high illumination intensity for determining limits below which biological effects (such as erythema or conjunctivitis) do not occur leads to the development of an effective relative radiation evaluation. After consideration of the most important biological effects of uv radiation, such an evaluation system was developed. The effect of luminescent foods was incorporated in the evaluation system. Illumination intensities, below which in a one-hour or eight-hour irradiation neither erythema, direct pigmentation, nor conjunctivitis occur, were given for various light sources. (tr-auth)

Radiation Effects on Plants

Refer also to abstracts 11997, 12013, 12018, 12029, and 12153.

12236 (AEC-tr-6646/4A, pp 11-15) RECOVERY OF X-RAY INDUCED DAMAGE IN CHLAMYDOMONAS REINHARDI. Hillova, Jana. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

In experiments with fractionated x-ray doses, the algae were stored in water between two dose fractions for different periods of time (40 to 200 min) at 26°C under continuous illumination. Colony counts were made on agar plates 6 to 7 days after inoculation. The tabulated data show a survival value of 67.5% with a time interval of 200 min between the two doses of 7600 RAD each; the survival value was 30.5% with a time interval of 40 min between the two doses. (H.L.W.)

12237 (AEC-tr-6646/4A, pp 77-81) THE EFFECT OF EXOGENOUS DEOXYRIBONUCLEIC ACIDS ON THE MITOSIS OF IRRADIATED AND NONIRRADIATED MERISTEMATIC CELLS OF VICIA FABA. Slotova, J. Translated from Bull. Boris Kidric Inst. Nucl. Sci., 17: No. 4/A, Suppl., (1966).

Primary roots of Vicia faba were irradiated on the sixth day after germination. After irradiation the roots were transferred to a DNA solution in which they remained for 2, 4, 6, 8, 16, and 24 hrs. A decrease of mitotic activity in irradiated root cells was recorded for 2, 4, and 6 hrs. For intervals of 8 and 16 hrs a gradual increase occurred so that the mitotic activities of the experimental and control groups were equal 24 hrs after irradiation. The decrease in mitotic activity of the roots kept in DNA solution was not as pronounced during the early intervals and the mitotic index reached the value of the control group sooner. The effect was more pronounced in roots cultivated in isologous DNA after irradiation. (H.L.W.)

12238 (JPRS-46977) RADIOBIOLOGICAL EXPERIMENTS ON COSMOS-110 BIOSATELLITE. Antipov, V. V.; Delone, N. L.; Nikitin, M. D.; Parfenov, G. P.; Saksonov, P. P. Translated from 19th Congress of the International Astronautical Federation, USSR, October 1968. 30p. CFSTI.

Seeds of Triticum vulgare, Hordeum distichum, Pinus silvestris, and Pisum sativum were placed in the cabin of the spacecraft satellite. Observations on the effects of cosmic radiation on the germination rate of seeds showed that there was a stimulating effect on barley seeds only. Chromosome rearrangements occurred in the primary radicles of pine seeds only. Experiments with onion bulbs (Allium cepa) resulted in stimulation of growth and an increased number of chromosome rearrangements. Tradescantia paludosa plants with inflorescences were placed in a contained secured to the spacecraft cabin. Cytological analysis of the microspores showed a small number of chromosome rearrangements. Experiments on lysogenic bacteria showed that when cells of Escherichia coli K-12 were x-irradiated with 3000 rads after the culture was returned from outer space, the number of induced phage particles was 509.9 per 10^5 bacterial cells. The development of induced phage was inhibited by chloramphenicol and mitomycin C. Studies on the alga Chlorella indicated that spaceflights of less than five days had no effect on viability or physiological functions. (H.L.W.)

12239 (NSJ-tr-139) STUDIES ON THE EFFECTS OF IAA, TIBA, AND X-RAY IRRADIATION ON THE APPEARANCE OF ABNORMAL SPIKELETS IN A SPECIAL VARIETY OF PADDY RICE "AKAHO." Shimizu, Masaharu; Kuno, Katsuji. Translated from Nippon Sakumotsu Gakkai Kiji, 35: 257-63(Dec. 1966). 13p. Dep.

The effects of IAA (3-indoleacetic acid), TIBA (2,3,5-triiodobenzoic acid), and x radiation on abnormal spikelets, especially regarding changes in sex expression, were investigated in the Akaho variety of paddy rice. The experiment was carried out in a phytotron at 25 to 30°C during the winter; short-day conditions promoted female and depressed male sex expression. External application of IAA further promoted femaleness and further depressed maleness. On the other hand, applications of TIBA and x radiation produced inhibitory effects on femaleness and stimulating effects on stamens. It was thought that gibberellin-like substances were dominant at an early stage of development of spikelets and that auxin-like substances became dominant at a later stage. It is believed that the effects of x radiation could be attributed to an inhibitory effect on the auxin level in the plant. (H.L.W.)

12240 (ORO-2583-6) A CYTOLOGICAL STUDY OF RADIATION INDUCED ALTERATIONS IN CYTOPLASMIC FACTORS CONTROLLING MALE STERILITY IN CORN. Progress Report. Edwardson, John R. (Florida Agricultural Experiment Station, Gainesville). Dec. 1, 1968. Contract AT(40-1)-2583. 18p. Dep. CFSTI.

The effects of x irradiation of corn (Zea mays) seedlings at doses of 5,000, 10,000, and 15,000 R on cytoplasmic sterility are reported. Field studies using selected progenies of the irradiated seedlings were conducted to determine the presence of fertility restorer genes. Cytoplasm from crosses of male sterile plants with fertile pollinators was examined cytologically for cytoplasmic constituents in relation to male sterile, maintainer, or restorer sterile tissues. Cytological techniques and vacuum dehydration-vapor fixation was used to determine the presence of viruses in plant cytoplasm. Results are reported from studies on Q virus in Datura stromonium and tobacco (Nicotiana tabacum) leaf tissues; exocortis virus in Petunia hybrida; sugarcane mosaic virus and maize dwarf virus in corn leaves; and watermelon mosaic virus in Lupinus angustifolius. (C.H.)

12241 (RLO-353-32) A STUDY OF FACTORS GOVERNING PLANT RADIOSENSITIVITY. Research Report, November 1, 1967–October 31, 1968. Nilan, Robert A.; Konzak, C. F. (Washington State Univ., Pullman). Nov. 15, 1968. Contract AT(45-1)-353. 22p. Dep. CFSTI.

Progress is reported on studies on the effects of x radiation on barley seeds. Results are reported from studies on the effects of radiation energy, temperature, water content, and oxygen content on the radiosensitivity of seeds, using the frequency of chromosome aberrations and the growth of seedlings as criteria. A list is included of 11 publications during the period covered by this report. (C.H.)

12242 COMBINED EFFECT OF FACTORS INVOLVED IN THE COSMOS-110 BIOSATELLITE SPACE FLIGHT ON PLANTS. Gertsuskii, D. F.; Petrovnin, M. G.; Alekseenko, L. V. Kosm. Biol. Med., 2: No. 6, 17-21(Nov.-Dec. 1968). (In Russian).

Data are presented characterizing the effect of space factors involved in the Cosmos-110 biosatellite flight on plants. The plants grown from the seeds flown onboard the Cosmos-110 biosatellite grew and developed faster, giving a higher yield than controls. As compared to the ground controls, the flight plants contained larger amounts of ascorbic acid and higher percentage of water, though the content of sugars was similar. These observations cannot be attributed only to the effect of ionizing radiation. They seem to be a combined result of space factors involved in the Cosmos-110 flight. (auth)

12243 ACTION OF VARIOUS TYPES OF IONIZING IRRADIATION ON FLAX AND HEMP. Sharkovskii, P. A.; Miller, A. T.; Rubina, E. A. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis, No. 5, 83-90(1968). (In Russian).

Studies of γ and neutron irradiation effects on flax (Linum usitatissimum) and hemp showed that flax had a much higher radioresistance. Data obtained showed that 100 krad of γ radiation was lethal for flax and 30 krad was lethal for the hemp and 10.0 krad of neutron fission was lethal for flax, while 3 krad was lethal for the hemp. It was also shown that small γ-ray doses (5.0 krad) stimulate plant growth and improve the technological quality of the flax stem. Seed irradiation before sowing did not affect the percent ratio of fat and fatty acids in the plants. (R.V.J.)

Radiation Effects on Microorganisms

Refer also to abstracts 11928, 11998, 12045, 12046, 12141, 12238, and 12251.

12244 (ORO-3347-4) PHYSIOLOGICAL STUDIES ON CLOSTRIDIUM BOTULINUM, TYPE F. Progress Report, December 1, 1966–November 30, 1967. Walls, Nancy W. (Georgia Inst. of

Tech., Atlanta. Engineering Experiment Station). Jan. 1969. Contract AT(40-1)-3347. 60p. Dep. CFSTI.

Five different strains of Clostridium botulinum, type F were utilized to perform experiments on: the effect of pH on toxin production; the effect of sublethal dosages of γ irradiation on toxin production by spores of type F C. botulinum; sporulation potential of nonproteolytic C. botulinum, type F under different nutritional conditions; and physiological and biochemical characterization of one strain of C. botulinum, type F. It was found that with the strain of C. botulinum, type F that was studied, media in which the pH was lower than pH 8.0 was unsuitable for germination of spores and so no growth or toxin production was seen in media with a pH less alkaline than 8.0. Type F toxin was able to persist at 30 C in buffers of different pHs at a rate influenced by both the pH and the temperature. Acid pHs were more suitable for long-term preservation of toxicity and this was particularly true if the toxin underwent an acid precipitation as occurred at pH 3.0 and pH 4.0. Nonproteolytic strains of C. botulinum, type F grew and sporulated best in a medium containing meat particles and freshly prepared infusion broth. A good percentage of the vegetative cells appearing in non-particulate media sporulated in experiments testing the effect of different media on spore production by these strains of type F but the percentage of cells growing in all nonparticulate media tested was low, so the total numbers of spores obtained were very low. Radiation studies on the effect of low doses of γ irradiation on toxin production by irradiated spores of C. botulinum, type F, strain Langeland were started. Using ^{137}Cs γ rays, the dosages of radiation utilized were 100,833 rads and 201,666 rads. It was found that at these radiation dosages, type F toxin appeared at high levels very early in the post-irradiation growth of the spores and that although the total final LD$_{50}$/ml of this toxin (1×10^4) was no greater than in unirradiated spores subcultured in the same medium, this level of toxicity was attained in irradiated cultures anywhere from six to seven days before it was reached in the unirradiated cultures at 30 C. When the cultures were incubated at 4 C and 10 C, no growth occurred at 4 C in any culture, irradiated or unirradiated, and outgrowth at 10 C was seen only in irradiated spore cultures. The amount of growth at 10 C increased as the radiation dosage was increased from 100,833 rads to 201,666 rads. (auth) (C.O.)

12245 (TID-24874) EFFECTS OF ULTRAVIOLET RADIATIONS ON THE CONTROL OF CELL METABOLISM AND SYNTHESIS IN ESCHERICHIA COLI B. Hamkalo, Barbara Ann (Massachusetts Univ., Amherst). Oct. 1968. 85p. Dep. CFSTI.

Thesis.

The effects of uv radiation (254 nm) on bacterial respiration, macromolecular synthesis, metabolism, and growth were dependent upon the strain of bacterium utilized and the carbon source that was oxidized before and after irradiation. The physiological changes in irradiated Escherichia coli B/r and B$_{s-1}$ were correlated with the presence of pyrimidine dimers in DNA and the ability of cells to cope with the uv-radioinduced damage. The substrate-dependent responses of B/r may be related to the rate of DNA synthesis upon resumption and the utilization of alternate metabolic pathways after irradiation. The physiological changes in this strain were interpreted as the functioning of a metabolic control mechanism that was particularly active after irradiation, and that acted to restore macromolecular balance, partly through the inhibition of the Krebs cycle. It was shown that the secondary response to the primary photochemical events that occurred within a few hrs after uv irradiation were not well correlated with survival data. It is suggested that uv irradiation caused changes in the physiology of bacterial cells that provided convenient systems for the study of metabolic regulation and control and processes involved in the initiation of DNA replication and cell division. (C.H.)

12246 EFFECT OF BETA- AND GAMMA-RAY IRRADIATIONS ON LYOPHILIZED MYCOBACTERIUM BOVIS. Guidi, V. (Univ., Naples); Germano, M. Igaku To Seibutsugaku, 74: 141-4(Mar. 1967).

For the lyophilized samples of Mycobacterium bovis BCG that were relatively uniform, the effect of β- and γ-irradiations were studied and compared with that of x irradiation. The results obtained were as follows. The dose-survival curves for β and γ irradiations (the doses 25,000, 50,000, 100,000, and 200,000 R) showed a single hit type, and were the same as that of x irradiation. The curve slope for β irradiation was similar to that of γ irradiation, although the former was more gradual. The effect of β irradiation was the same as that of γ irradiation. On the other hand, the slope for x irradiation was sharp, and the lethal effect per equal dose was larger for x irradiation than for β or γ irradiations. The frequency of mutations, with INH-resistant mutation as an index, increased with dose for x irradiation (but decreased when the dose reached 200,000 R), but for γ and β irradiations, this was not observed. (NSA of Japan)

Radiosterilization and Radiopreservation

Refer also to abstracts 12018 and 13606.

12247 (COO-1539-1) EFFECTS OF GAMMA RADIATION AND CHEMICAL TREATMENT ON QUALITY OF STORED POTATOES FOR FRESH MARKET AND PROCESSING USAGE. Final Report. Kwiat, Eugene V. (Pillsbury Co., Minneapolis, Minn.). Feb. 22, 1968. Contract AT(11-1)-1539. 94p. Dep. CFSTI.

In order to evaluate the potential role of irradiation treatment for sprout inhibition of potatoes for long-term commercial storage, comparisons were made of potatoes treated with γ radiation and two chemical sprout inhibitors — CIPC (Chloro-N-Isopropyl-Phenyl Carbamate) and MH-30 (Maleic Hydrazide). Potato varieties evaluated consisted of Pontiac, Kennebec, and a small quantity of Russet Burbanks. Stored potatoes were evaluated periodically as French Fries, potato chips, table stock, and dehydrated dice and flakes. Chemical, physical, and organoleptic tests were employed. Irradiation and CIPC treatments were effective as sprout inhibitors for the one-yr storage period at approximately 55°F and 75% relative humidity. MH-30 potatoes evidenced small rosette sprouts early in storage and these sprouts increased in size and number with time. Control samples sprouted within two months from time of harvest and by six months had sprouted profusely. Potatoes stored at 45°F and 50°F were generally in good condition after eight months from harvest. Even untreated potatoes were satisfactory for some processing uses at this time. Irradiated and CIPC treated Pontiacs showed almost parallel shrink losses on storage at 55°F and 75% relative humidity with the irradiation group marginally better through nine months from harvest. MH-30 potatoes were generally higher in shrink during storage. The Control treatment for both varieties was poorest and was removed from the test after the seven-month evaluation. Kennebecs treated with CIPC had less shrink than the irradiated and MH-30 samples. Irradiated Russet Burbank potatoes held up fairly well through nine months from harvest but were generally unsuitable for table stock after this period. A lower storage temperature and higher humidity would have reduced shrink losses and extended storage life of potatoes. Quality of the processed potato products was primarily attributable to the turgor condition of the raw potatoes at each specific evaluation period and was not generally influenced by the sprout inhibition treatment per se. That is, no apparent differences were noted in flavor or color of dehydrated potato dices and flakes, potato chips, or table stock caused by a specific sprout inhibition method. Evaluation of frozen French fries was done primarily with the Kennebec variety. Generally rots and breakdown accounted for poorer results with irradiation treatment, but sufficient data are not available to warrant a general conclusion in this regard. There was little effect on texture with sprout inhibiting treatment and final product yield and quality were directly affected by condition of potatoes as received. In this study both irradiation and CIPC treatments of Kennebec and Pontiac yielded similar quality of processed and table stock potatoes during storage. Marginal differences were noted favoring irradiation in some instances at particular evaluations and CIPC treatment in others. These differences are not considered significant. Both irradiation and CIPC treatments were better than MH-30 because the latter sprouted during storage. Irradiated Russet Burbanks held up considerably better than untreated potatoes, again because of sprouting. General desiccation and loss of turgor accounted for most of the quality loss during storage. This would be reduced if lower storage temperature and higher humidity were employed. The economics of irradiation treatment of potatoes do not appear favorable if it is used by one potato processor. The cost is envisioned as being very competitive if the irradiation facility is used yr-round for multi-purposes. Until this stage is reached, costs will be moderately higher than competitive processes. (auth)

12248 (ORNL-IIC-14) RADIATION PROCESSING OF FOOD PRODUCTS. Metlitskii, L. V.; Rogachev, V. N.; Krushchev, V. G. Machine translation edited by Martha Gerrard, F. E. McKinney, P. S. Baker (Oak Ridge National Lab., Tenn.), and Eugen Wierbicki (Army Natick Labs., Mass.), from Radiatsionnaya Obrabotka Pishchevykh Produktov, Izdatel'stvo Ekonomika, Moscow, 1967. 121p. Dep. CFSTI.

Separate abstracts were prepared for the five sections of this book. A bibliography containing 82 references is included. (H.L.W.)

For abstracts of individual sections see: 12249–12253.

12249 (ORNL–IIC–14, pp 5-19) IRRADIATION OF POTATOES AND OTHER VEGETABLES TO PREVENT SPROUTING. Metlitskii, L. V. Translated from Radiatsionnaya Obrabotka Pishchevykh Produktov, Izdatel'stvo Ekonomika, Moscow, 1967.

The effects of ionizing radiation on sprouting of potatoes and other vegetables are discussed. It was found that small doses had a stimulating effect and that large doses had an inhibitory effect. The role of ATP, nucleic acids, and auxins in the growth of potato tubers and effects of radiation on these substances are discussed. Studies on different plants showed that potato tubers, onion bulbs, and garlic bulbs had different radiosensitivities. The resistance of vegetable tissues to pathogenic microorganisms is the result of formation of antibiotic substances; irradiation decreases the capability of the plant tissues to form antibiotics. Experiments on potatoes showed that irradiated tubers were infected more rapidly than controls only if the pathogen was introduced shortly after irradiation. The significance of the radiation dose and the characteristics of the plant at the time of irradiation is discussed with regard to resistance of onion and garlic to pathogenic microorganisms. The effects of ionizing radiation on the chemical composition of potatoes, onion, and garlic are discussed. The basis for industrial approval of a method for irradiating potatoes under production conditions is discussed. (H.L.W.)

12250 (ORNL–IIC–14, pp 20-32) RADIATION DISINFESTATION OF FOOD PRODUCTS. Rogachev, V. I. Translated from Radiatsionnaya Obrabotka Pishchevykh Produktov, Izdatel'stvo Ekonomika, Moscow, 1967.

Economic losses of grain and other foods infested with insects are discussed. Physiological and biochemical disturbances in insects following treatment with ionizing radiations are dependent on the stage of development of the insect and the radiation dose. A table is presented to show effects of dose on time for disappearance of 99.9% of beetles, weevils, and other insects from grain. Studies on the effects of temperature produced varying results. It was found that some insects lived longer when the storage temperature after irradiation was below optimum, while others had a shorter life. Studies on different developmental stages of the rice weevil showed a high percentage of loss of eggs and larvae with low doses. Irradiation of larvae, pronymphs, and young pupae with 5 krads resulted in sterile adults with decreased viability. Effects of γ radiation on carbohydrates, proteins, and certain enzymes of wheat grains were examined. Doses up to 100 krads did not have a significant effect on carbohydrates or proteins. With doses greater than 100 krads gluten became tough and began to break into short pieces. At the same doses, starch decomposed to maltose and the iodine number of fats decreased. Doses up to 2500 krads did not change significantly the bread-baking properties of wheat. Irradiation of food concentrates such as pea soup, oatmeal, rice, buckwheat, and pearl barley at doses that caused disinfestation did not change the organoleptic properties. Irradiation of dried potatoes and other vegetables had little effect on their chemical composition. Organoleptic properties of dried fish were not changed by doses up to 500 krads. (H.L.W.)

12251 (ORNL–IIC–14, pp 33-66) USE OF IONIZING RADIATION TO PREVENT MICROBIAL SPOILAGE OF FOOD PRODUCTS. Rogachev, V. I. Translated from Radiatsionnaya Obrabotka Pishchevykh Produktov, Izdatel'stvo Ekonomika, Moscow, 1967.

Mechanisms of action of ionizing radiation on microorganisms are briefly reviewed. According to the target theory, there are sensitive spots, or targets, in the cell that are ionized by radiation causing damage to the entire cell. Other theories of the action of ionizing radiation are discussed. Methods of reactivation following sublethal doses are also discussed. It was found that characteristics of the development of irradiated microorganisms had practical value in determination of optimum conditions for irradiation of food products, the establishment of conditions and storage times of the irradiated products, and the carrying out of microbiological analyses of irradiated products. Radiation resistance of microorganisms was estimated by determining the curve of viability as a function of radiation dose. The most radiosensitive bacteria were *Pseudomonas aeruginosa*, *Escherichia coli*, *Salmonella typhosa*, and *S. marcens*. Radioresistant organisms were *Micrococcus radiodurans* and spores of Bacillus and Clostridium. Studies on effects of dose rate showed that sensitivity of microorganisms to irradiation sometimes increased with increasing dose rate, although the opposite effect was also observed. Experiments with different types of microorganisms established the general rule that radiation resistance decreases in the presence of oxygen. Effects of radioprotective compounds, cysteine, cysteamine, amino acids, glucose, sucrose, glycerol, mannitol, and ethanol, on microorganisms are discussed. A table is presented to show protective effects of different substances in the culture medium on various species of Salmonella exposed to γ radiation. Effects of sensitizing substances, such as iodoacetamide, nitric oxide, and halogenated pyrimidines, on microorganisms were investigated. Effects of water, temperature, and radiation source on radiation resistance of microorganisms were examined. Effects of heat and chemical preservatives on radiation resistance of *Clostridium botulinum* and other microorganisms were studied. Effects of radiation on organoleptic properties and enzyme activity in fruits, vegetables, fish, beef, and pork were investigated. Tables giving maximum doses that do not cause changes in the taste of foods are presented. Methods of preventing undesirable radio-induced organoleptic changes include use of freezing, vacuum, oxygen-free atmosphere, addition of packets containing sorbent, heat treatment, and additives. Experiments on partial suppression of microorganisms by radiation established that a large proportion of the organisms were destroyed by doses that did not cause product deterioration. Studies on radiation processing of beef and lamb established that irradiated meat could be transported from Australia to England without freezing or using dry ice. Methods of preventing rancidity and exudation of meat juice are discussed. Advantages of irradiating half-cooked meat are pointed out. Studies on radiation processing of chicken showed that the shelf life was lengthened if the chickens were fed a special ration containing antioxidants to prevent damage to fats. Irradiation of fish at doses of 0.6 Mrad and packaging under vacuum in plastic significantly extended the storage time without noticeable changes in quality. Storage time of irradiated fruit is determined by degree of infestation of the surface by phytopathogenic organisms. Difficulties of disinfection are pointed out. Studies on the problem of finding radiation doses at which microorganisms are partially destroyed but at which the quality of the fruit is not affected were carried out. Results indicated that the dose should be 250 to 300 krads. The effects of these doses on decreasing the resistance of fruits to diseases were studied. Problems related to the storage of irradiated fruits are discussed. (H.L.W.)

12252 (ORNL–IIC–14, pp 67-81) WHOLESOMENESS AND FOOD VALUE OF IRRADIATED FOOD PRODUCTS. Rogachev, V. I. Translated from Radiatsionnaya Obrabotka Pishchevykh Produktov, Izdatel'stvo Ekonomika, Moscow, 1967.

Investigations on the occurrence of induced radioactivity in food products revealed that radioactivity may be induced in foods if the neutrons or other radiations used have an energy >10 Mev. Therefore nuclear reactors cannot be used to process food products unless measures are taken to absorb the neutrons. To ensure that there will be no induced radioactivity in irradiated food, the irradiation should be done with either radioisotopes, such as ^{60}Co or ^{137}Cs or with accelerator electrons of energy $\leq$ 10 MeV. To study toxicity and carcinogenicity of irradiated food products, rats were given a ration made up from nine food products that had been irradiated with 6 Mrad doses and enriched with vitamins. There were no differences in growth, reproduction, or lactation of these rats compared with controls. Studies on effects of radiation on vitamins, proteins, carbohydrates, and lipids are reported. It was concluded from experimental work on the feasibility of using irradiated foods that irradiated foods are safe for consumption and that many irradiated products are equal in taste and food value to products not irradiated but preserved by other methods. (H.L.W.)

12253 (ORNL–IIC–14, pp 82-107) SOURCES AND FACILITIES FOR RADIATION PROCESSING OF FOOD PRODUCTS. Krushchev, V. G. Translated from Radiatsionnaya Obrabotka Pishchevykh Produktov, Izdatel'stvo Ekonomika, Moscow, 1967.

Available sources for processing food are x rays, γ rays, and accelerator electrons. The following γ sources are considered for industrial processing of foods: irradiation loops in nuclear reactors, spent uranium fuel rods during the time they are stored for decay of fission products, ^{137}Cs, and ^{60}Co. Each of these is discussed with regard to use in the food industry. Irradiation facilities are classified as experimental research, pilot plant, and production. The following experimental research irradiation facilities are discussed: experimental gamma irradiators EGO 2, EGO 20, GUBE, and gamma irradiators made in Canada. Pilot plant installations have irradiators that create a uniform radiation field and are either hollow cylinders or two-plane systems. High-intensity gamma irradiators in operation at VNIIKOP and VNIIZ are described. A pilot plant for grain disinfestation by γ radiation in operation in the United States is described. A mobile irradiator for γ radiation of fruits and berries in operation at the University of California is described. It is necessary to obtain high efficiency-of-utilization coefficients in industrial irradiation; methods of solving this problem are discussed. A production-scale irradiator for potatoes at the Dzerzhinskii base for Moscow fruit and vegetable procurement is described. A stationary facility for irradiating potatoes was developed in Quebec, Canada. The mobile food irradiator, IRMA-400-1, using ^{137}Cs as the radiation source, was developed at Saclay, France. (H.L.W.)

12254 (RISO-185) DOSIMETRY IN RADIOSTERILIZATION OF MEDICAL PRODUCTS. Holm, Niels W. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1968. 25p. Dep.

Dosimetry systems for radiosterilization of medical products were developed. Some of the work formed the basis of the dosimetry procedures included in the IAEA's recommended Code of Practice for Radiosterilization of Medical Products. Special efforts were made to develop simple and reliable calorimeters for absolute calibration of secondary dosimetry systems, and the results of the work with the thermos flask calorimeter and the oxalic acid dosimeter are reported. A number of general problems in radiosterilization dosimetry are also discussed. (auth) (Denmark)

12255 (TID-24633) CHEMISTRY OF RADIOPASTEURIZED SEAFOODS. Period Covered: October 1, 1966-September 30, 1967. Ronsivalli, L. J.; King, F. J.; Mendelsohn, J. M.; Gadbois, D. F.; Brooke, R. O.; Holston, J. A. (Bureau of Commercial Fisheries, Gloucester, Mass. Technological Lab.). Contract AT(49-11)-2443. 39p. Dep. CFSTI.

In previous work evidence was obtained that radiation has little effect on the amino acids and on the B-vitamins in haddock fillets and soft-shell clam meats. Analytical methods were developed for studying the effects of radiation on the flavors and odors of fish, and the penetrability of sodium nitrite and sodium tripolyphosphate in haddock fillets was determined. These salts have been found to inhibit the growth of Clostridium botulinum Type E. In research conducted recently, a Time-of-Flight mass spectrometer was used to identify volatile chemical compounds in irradiated and nonirradiated seafoods, and a protocol was designed for studying these compounds according to chemical classes. It was determined that dimethyl sulfide is the dominant component in the volatiles of clams, and its range of concentrations was determined which can be described as typical clam odor. The effects of radiation and reducing gases on five species of typical fish-spoilage bacteria and the penetrability of disodium ethylenediaminetetraacetate dihydrate (known to inhibit the growth of Clostridium botulinum Type E) into fish fillets were also studied. (auth) (C.O.)

12256 (TID-24776) IRRADIATION PRESERVATION OF FRESHWATER FISH. Annual Report, April 15, 1966-April 14, 1967. Graikoski, J. T.; Kazanas, N.; Watz, J.; DuCharme, S.; Emerson, J. A.; Seagran, H. L. (Bureau of Commercial Fisheries, Ann Arbor, Mich.). Dec. 1968. Contract AT(49-11)-2954. 78p. Dep. CFSTI.

The effect of storing previously irradiated (0.1, 0.2, and 0.3 Mrad of γ rays) yellow perch (Perca flavescens) fillets in a controlled atmosphere (CA) environment at refrigeration temperatures (33° to 37°F) was evaluated. The CA atmospheres employed consisted of 6 and 12% CO_2, 1 to 2% O_2; the balance of the atmosphere was N_2. A two-fold increase in the number of days until the microbial population reached 10^8 per gram of fish flesh was observed when irradiated fish were stored under CA storage as compared to air storage at refrigeration temperatures. This also resulted in an increase in the shelf life of the fish, as determined by organoleptic evaluations. Mechanisms involved in these effects and preliminary experiments with other types of fish are discussed. (auth) (C.O.)

12257 (TID-24778) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE OF 34°F TO 50°F. Annual Report, June 29, 1962-June 28, 1963. (Continental Can Co., Inc., Chicago, Ill. Metal Div. Research and Development). Aug. 15, 1963. Contract AT(11-1)-1183. 86p. Dep. CFSTI.

The effects of culture medium composition and temperature on the outgrowth time of spores of four strains of Clostridium botulinum Type E were determined. Emphasis was placed on studies on the growth of Clostridium on homogenates of haddock and shrimp preliminary to studies on the effects of radiation processing on extension of the refrigerated storage life of sea foods. (C.H.)

12258 STERILIZATION OF CLINICAL EQUIPMENT BY γ RADIATION. Boer, H. A.; Ouwerkerk, Th. Atoomenergie Haar Toepass., 10: 232-8(Oct. 1968). (In Dutch).

Sterilization of medical equipment by γ radiation has the advantage that the equipment may be sealed, labeled and readied for shipment before sterilization; a great variety of packing materials may be used. As the temperature is not increased during the process, low-melting and unstable compounds may be sterilized by this method. The dose may be easily controlled by checking the exposure time, as the dose rate is continuously monitored. Unlike sterilization by heat and gas, the γ radiation technique is not affected by convection, conduction, diffusion, and permeability; however, it may reduce the structural strength of the clinical equipment. Because of the high degree of automation, the irradiation plants require little labor. As long as sufficient shielding is provided, the plant capacity may easily be increased by using a larger source. The investment and operational costs for 200 and 800 kCi plants are presented in tabular form. (TTT)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

12259 (NOLTR-68-16) PROCEEDINGS OF SYMPOSIUM ON TiNi AND ASSOCIATED COMPOUNDS, SILVER SPRING, MARYLAND, APRIL 3-4, 1967. Wang, Frederick E. (ed.) (Naval Ordnance Lab., White Oak, Md.). Feb. 20, 1968. 244p. (CONF-670454).

Eighteen papers presented at a two-day "Symposium on TiNi and Associated Compounds" held at the Naval Ordnance Laboratory, Silver Spring, Maryland, on April 3 and 4, 1967 are included. The purpose of the symposium was to bring together research workers in this subject area to exchange their latest information and ideas and also to bring forth a better understanding of TiNi-type alloys and the unique properties associated with them. The discussions that followed each paper are included. (auth)

12260 (ORNL-4330) FUELS AND MATERIALS DEVELOPMENT PROGRAM. Quarterly Progress Report for Period Ending June 30, 1968. Patriarca, P.; Harms, W. O. (comps.); Rucker, D. J. (ed.) (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 366p. Dep. CFSTI.

Progress is reported on development of nitride and sol-gel fuels, radiation effects on fission gas release from fuels, Zr metallurgy research, alkali metal corrosion, radiation effects on refractory materials, LMFBR materials research, radiation effects on materials used in nuclear technology, W metallurgy, nondestructive testing, joining nuclear materials, fuel development, SAP development, and metallurgy of refractory metals and alloys. (J.R.D.)

12261 (WARD-3791-25) VANADIUM ALLOY CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1968. Bishop, E. C.; Nadler, R. A.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct. 1968. Contract AT(30-1)-3791. 61p. Dep. CFSTI.

The nuclear and economic analysis of vanadium fuel element cladding was completed. Melting of all 13 ingots of the five vanadium alloys is virtually complete. V-20Ti sheet material has been supplied, and the extrusion is proceeding. The effects of prior cold work and annealing temperature on the grain growth characteristics of the VANSTAR alloys have been examined. Excellent high-temperature creep resistance has been demonstrated for these alloys. The ductile-brittle bend transition temperature increases with annealing temperature. The tensile properties of the VANSTAR alloys and the V-20Ti alloy has been examined over the temperature range ambient to 1000°C. There is a linear dependence of yield strength on temperature for all alloys. The VANSTAR alloys have minimum elongations of 20% at the 600 to 800°C strain aging region. The low-velocity sodium-corrosion loop system, VTL-1, has accumulated over 1600 hours of operation, and the high-velocity system, VTL-2, over 600 hours of operation. Samples of the alloys VANSTAR-7, VANSTAR-9, and V-20Ti gained weight after both 500- and 1500-hour exposure, at 675 to 800°C, to sodium containing ~15 ppM oxygen and flowing at 5 fps. All alloys exhibited surface hardening due to exposure, and analysis has indicated that in the VANSTAR-9 alloy, this may be due mainly to absorption of carbon. No significant reduction in tensile ductility at 800°C was shown by the VANSTAR-9 alloy after exposure to sodium. Samples were removed from VTL-2 after 500 hours exposure. VANSTAR-8 and VANSTAR-9 tensile samples will be loaded into capsules prior to insertion in EBR-II, Row 2. The first two capsules, each containing one vanadium alloy sample, have been shipped to EBR-II. (J.C.W.)

12262 BEHAVIOUR OF DENSE MEDIA UNDER HIGH DYNAMIC PRESSURES. SYMPOSIUM H.D.P., I.U.T.A.M., PARIS, SEPTEMBER, 1967. New York, Gordon and Breach, 1968. 574p. (In English and French). (CONF-670914).

Separate abstracts have been prepared for each of seven of the 61 papers presented on the behavior of dense media under high dynamic pressures. Papers for which no abstracts were prepared are concerned with detonation waves, shock waves, alkali halide structure under pressure, use of gas guns in pressure experiments, carbon density, compression of magnesium and ammonium sulfate, compression of rocks, tensile shock tests, shock-induced demagnetization of metals, shock strain gages, and cratering. (F.S.)

For abstracts of individual papers see: 11684, 11703, 12317, 12318, 12345, 12426, and 12436.

12263 DEPLETED URANIUM IN INDUSTRY. Seedhouse, K. G. (United Kingdom Atomic Energy Authority, Risley, Eng.). S. Afr. Mining Eng. J., 79: 1515-17(July 12, 1968).

Uses of depleted U from reactors are suggested. It may be used for protective shielding in equipment using γ sources and x rays, and for isotopic generators. It may be used as counter-weights for aircraft. Phase diagrams exist for U with most elements. Most alloying elements will increase the strength, hardness, and corrosion resistance of U when added in small amounts. Lead-U alloys in the range of 2 to 8 wt % U have been studied in connection with possible anti-friction applications. In general, U has no decisive advantages over less expensive alloying elements in steel. Corrosion tests with steels indicate that U will reduce their corrosion in HCl and H_2SO_4. Uses of U with Cu and Ni are based on deoxidizing the molten metals and improving the malleability of certain alloys. The performance of conventional Ni catalysts in the steam reforming of naphtha to town gas or synthesis gas can be improved by U_3O_8. Sulfur can be removed from the naphtha, before reforming, by using a catalyst containing U_3O_8 on alumina to decompose sulfur to H_2S, which is then removed conventionally. The replacement of Bi by U_3O_8 for catalyzing the production of acrylonitrile from propylene has been achieved. A catalyst consisting of U_3O_8 on a carrier has been found to be very effective for purifying exhaust gas from cars. Uses of U in the electrical industry, glass, and ceramics are also reviewed. (BBB)

Corrosion and Erosion

Refer also to abstracts 11596, 11690, 12287, 12434, 12962, and 13585.

12264 (AECL-3223) OXIDE TOPOGRAPHY ON CRYSTAL-BAR AND REACTOR GRADE SPONGE ZIRCONIUM. Cox, B.; McIntosh, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1968. 29p. Dep. CFSTI. CAN $1.00.

A study of the surface topography of oxide films formed on unalloyed zirconium in steam or water at 300°C has revealed no processes which might lead to the formation of protruding oxide needles or platelets. All features having the appearance of needles or platelets when seen in profile could have been produced by oxide cracking and loss of adherence at the interface leading to curling of the oxide. The incidence of oxide cracking is determined by the conditions under which oxidation is carried out. Specimens oxidized at high pressure in water showed a tendency for the oxide to crack and peel when less than 2000Å thick which leads to the platelet like features. During oxidation at low pressure the sites of rapid oxidation lead to patches and ridges of thick oxide which crack along lines of maximum stress; there is little tendency for the oxide to peel when formed at low pressure until a late stage in the oxidation. (auth)

12265 (BNL-13062) PRELIMINARY CORROSION RESULTS OF HAYNES 25 AND 304 STAINLESS STEEL WITH 4 AND 12 PPM OXYGEN IN SODIUM AT TEMPERATURES UP TO 760°C. Romano, A. J.; Wachtel, S. J.; Klamut, C. J. (Brookhaven National Lab., Upton, N. Y.). [nd]. 5p. (CONF-681106-11). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

High velocity (~22 ft/sec) corrosion tests are being performed in two pumped loops fabricated entirely of stabilized stainless steel in which specimens are exposed to Na in a 24-in.-long rising temperature region. Preliminary results show the cobalt base alloy Haynes 25 has better corrosion resistance than 304 stainless steel to Na containing 12 ppM O. Possibility of Fe deposition on Haynes 25 surface exists. Prolonged testing should reveal whether the corrosion rate or the deposition rate will predominate at equilibrium. (F.S.)

12266 (BNWL-SA-2181) COVER GAS IMPURITIES AND THEIR INTERACTIONS WITH SODIUM. Barton, G. B.; Maffei, H. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 28, 1968. Contract AT(45-1)-1830. 19p. (CONF-681106-8). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

Cover gas analysis instruments including electrolytic and aluminum film hygrometers, electrolytic and Hersch cells, chromatographs, hydrogen flame ionization detectors, mass spectrometers, and nondispersive infrared analyzers were evaluated for application in the Fast Test Reactor. Various parameters of cover gas reactions with sodium such as methane and Na in He gas and methane and Na in Ar gas are discussed. The effects of Na volume and surface area on the reaction rates of methane with Na, and initial results of the reaction of CO_2 and CO with Na are examined. (F.S.)

12267 (CEA-CONF-1031) COMPATIBILITY COMPARISON OF (U,Pu)C AND U-Pu-C-Mo WITH STAINLESS STEEL. Mouchnino, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 4p. (CONF-680322-4). Dep.

From Conference on the Physics of Metals, Berlin, Germany.

The addition of molybdenum to (U,Pu)C improved the compatibility of (U,Pu)C with stainless steel. With and without molybdenum (U,Pu)C reacts with stainless to give $(U,Pu)(Fe,Ni)_2$ and $(Cr, Fe)_{23}C_6$ at the interface. It was observed, however, that the quantity of chromium carbides precipitated in the steel is far lower for U-Pu-C-Mo than for (U,Pu)C. (auth)

12268 (JAERI-1161) OXIDATION KINETICS AND OXIDE FILM BREAK-AWAY OF ZIRCONIUM AND ITS ALLOYS AT HIGH TEMPERATURES. Nomura, Sueo; Akutsu, Cho (Japan Atomic Energy Research Inst., Oarai. Oarai Research Establishment). Mar. 1968. 19p. Dep.

The oxidation of Zr, Zircaloy-2, and Zr binary alloys with Cu, Ni, Sn and Nb was studied emphasizing the mechanism of rate transition in 600 to 850°C dry oxygen. The results obtained from the continuous gravimetric measurements were compared with the oxide morphology involving hot-stage microscopy, x-ray and electron diffraction data, and electron beam micro probe analysis of the oxide-metal interfaces. No close relationship was found between the rate transition and either cracking or transformation of the oxide. A mechanism involving the recrystallization of the oxide is discussed based on a consistent relationship between the kinetic behavior and the behavior of the alloying elements during the oxidation. Stability of anion vacancies in ZrO_2 was pointed out as an important factor determining the rate transition. (tr-auth)

12269 (KFK-762) COMPATIBILITY OF REFRACTORY METALS WITH URANIUM DIOXIDE. Vollath, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Apr. 1968. 32p. (In German). (EUR-3952). Dep.

The compatibility of UO_2 with Ta, Mo, W, Rh, W-26% Rh, and W-50% Mo was investigated in the temperature range between 2000 and 2500°C. The destruction of the metal in the presence of UO_2 occurs either, as with Ta, by the formation of a new lower melting phase or, as with W and W alloys, by the coating of the grain boundaries with UO_2. This can lead to a splitting of the grain boundaries and appears to limit the applicability of W and W alloys sharply. The metals Mo and Rh seem to be more compatible. Whereas with Mo there is in some cases a coating of the grain boundaries with UO_2, this does not occur with Rh. (J.S.R.)

12270 (ORNL-TM-2422) EXAMINATION OF MODIFIED PILLAR AND SIMULATED WASTE CONTAINER TEST HEATERS. Kegley, T. M. Jr.; Empson, F. M. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

Two modified pillar heaters and one simulated waste container test heater from the radioactive waste disposal demonstration in the Carey salt mine at Lyons, Kansas, were examined by pressure testing, chemical analysis, and metallography. Before the examination, the heaters had been exposed to the natural salt environment at 124 to 400°C for 3 to 16 months. Stress-corrosion cracking and pitting were found in the heaters that were fabricated of type 304L stainless steel. The stress-corrosion cracking was caused primarily by the presence of water condensate containing chloride. Moderate rusting of the carbon steel modified pillar heater appeared to be inconsequential since there was no noticeable reduction of wall thickness. (auth)

12271 (RCN-100) CORROSION OF ZIRCONIUM ALLOY SAMPLES IN 340°C CIRCULATING WATER BEFORE AND AFTER THE PERFORMANCE OF A DECONTAMINATION TREATMENT. van der Linde, A. (Reactor Centrum Nederland, Petten). Aug. 21, 1968. 27p. (CONF-681034-1). Dep.

From Zirconium Symposium, Pilsen, Czechoslovakia.

Nine sets of Zircaloy-2, eleven sets of Zircaloy-2, three sets of Zr-2½ Nb and two sets of Zr-3Nb-1 Sn samples, mainly tube specimens, were exposed in an out-of-pile water loop for up to 650 days. The loop test conditions were: 340°C, pH 9 to 10 with ammonia, oxygen 0.1 to 0.2 ppM and hydrogen 0.15 to 0.35 ppM. The measured weight gain data show that the Zircaloy oxidation relations, obtained from autoclave experiments, can be used for long-time-exposure calculations of the weight gains in circulating water. After an accidental contamination a two-step Turco decontamination treatment was given to all samples. The influence of this treatment on the weight rate and on the deviations of measured from calculated weight gain is presented and discussed. (auth)

12272 (WAPD-Trans-105) APPLICATION OF INTENSIOSTATIC POLARIZATION FOR THE REMOTE MEASUREMENT OF THE INSTANTANEOUS CORROSION RATE OF Zr-Nb 2.5 ALLOY IN AQUEOUS SOLUTIONS OF MIXTURES OF HF + HNO_3 + H_2SO_4. Beran, Jaroslan; Krausova, Marie; Sulc, Josef. Translated from pp 345-59 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, General Proceedings, Plzen, Czechoslovakia, Skoda Works, October 20-21, 1966. 19p. (CONF-661059-1). Dep. CFSTI.

A description is presented of an electrochemical remote-measurement method of the momentary corrosion rate of Zr-Nb 2.5 alloy in aqueous solutions of HF + HNO_3 + H_2SO_4 mixtures, based on determining the slope of the initial linear region of the galvanostatic cathodic polarization curve. By comparing the results of electrochemical measurements with those obtained by conventional weight-loss measurements a calibrating curve is plotted. (auth)

12273 REPLENISHED AUTOCLAVE FOR IN-REACTOR CORROSION STUDIES. Asher, R. C.; Kirstein, T. B. A.; Mitchell, E. J. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Energy, 158-62(Nov.-Dec. 1968).

The autoclave described is used to study the effects of intense reactor radiation on the corrosion of Zr alloys in hot water. The in-reactor section is made mainly from Zr-2½% Nb alloy and Ti and occupies a hollow fuel element in the PLUTO reactor. The temperature of the specimens under study can be maintained constant at up to 340°C, the pressure being 3,000 lb $in.^{-2}$. Control of the water chemistry is facilitated by continuously pumping the water through the autoclave at 10 ml min^{-1}. (UK)

12274 SOLUBILITY OF HYDROGEN IN NICKEL-MOLYBDENUM AND NICKEL-TUNGSTEN ALLOYS. Lange, Klaus W.; Schenck, Hermann (Technische Hochschule, Aachen). Z. Metallk., 60: 62-8(Jan. 1969). (In German).

The solubility of hydrogen in nickel-molybdenum and nickel-tungsten alloys was measured between 1100 and 1800°C and was expressed analytically by a potential series. It is endothermic and increases with increasing temperature. Molybdenum—and to a larger extent tungsten—decrease the solubility of hydrogen in nickel considerably. The efficiency parameters are positive and temperature dependent. The concentration dependence of the enthalpy of solution and of the entropy of solution are expressed analytically. (auth)

12275 OXIDATION OF 304L STAINLESS STEEL BY STEAM AND BY AIR. Bittel, J. T.; Sjodahl, L. H.; White, J. F. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. Corrosion, 25: 7-14(Jan. 1969).

Oxidation of 304L stainless steel was measured in steam and in air at 1000 to 1375°C using a thermogravimetric technique. This temperature range is of interest in the analysis of a reactor loss-of-coolant accident. Experiments in steam showed initial linear weight gain with time for the first 6 to 28 minutes, followed by parabolic rate behavior. The linear reaction rate constant W/t was found to be $1.1 \times 10^5 \exp(-44{,}350/RT)$ while the parabolic constant W^2/t was found to be $2.4 \times 10^{12} \exp(-84{,}300/RT)$, where T is in °K and W is in mg/cm^2 and t is in sec. The parabolic rate controlling process is diffusion through an Fe-Ni-Cr spinel layer observed in the inner layer of the scale. The oxidation of 304L stainless steel by air from 1100 to 1360°C was slow compared with the oxidation by steam in this same temperature range, parabolic rates being lower than those in steam by a factor of $\sim 10^3$. Although x-ray diffraction observed Fe_3O_4 (major) and Fe_2O_3 (minor) on the surface of the coatings formed in air at temperatures of 1360°C and below, Cr_2O_3 was found at the metal-oxide interface. The low rates in air thus reflect the formation of a protective Cr_2O_3 film. The rate in air at 1375°C is exceptionally rapid compared with those at the lower temperatures possibly because of the Fe-FeO liquidus at 1370°C. (auth)

12276 INFLUENCE OF ALLOYING ELEMENTS ON THE STRESS CORROSION BEHAVIOR OF AUSTENITIC STAINLESS STEEL. Loginow, A. W.; Bates, J. F. (United States Steel Corp., Monroeville, Pa.). Corrosion, 25: 15-22(Jan. 1969).

In certain applications, stress corrosion cracking of austenitic stainless steels has occurred when these steels are subjected to tension stresses (residual and applied) and are exposed to hot chloride solutions. Although stress corrosion cracking can be prevented by treatments to relieve residual stresses and by control of the environment, such procedures are expensive and not always reliable. An extensive study was therefore undertaken to develop a steel that would be inherently resistant to stress corrosion cracking. The results of the study, conducted on stressed specimens of experimental steels immersed in a boiling 42% magnesium chloride solution, showed that carbon and nickel improved the stress corrosion resistance of annealed steels, and nickel and silicon increased the resistance of cold-worked steels. It was also found that nitrogen decreased the resistance of annealed steels whereas phosphorus and molybdenum decreased the resistance of cold-worked steels. Manganese, copper, chromium, sulfur, and aluminum had little effect on stress corrosion resistance. This study resulted in the formulation of a steel composition containing 18% chromium, 18% nickel, 2% silicon, and 0.06% carbon, with low phosphorus and molybdenum contents. This steel was melted in an electric furnace and its stress corrosion, corrosion, and mechanical properties were determined. Test results show that the new steel (called USS 18-18-2 stainless steel) is much more resistant to stress corrosion cracking than currently available austenitic stainless steels. Furthermore, the resistance of this steel is better than that of a 20% chromium, 34% nickel alloy that is being marketed for its resistance to stress corrosion cracking. (auth)

12277 CORROSION AND HYDROGEN PICKUP OF ZIRCALOY IN CONCENTRATED LITHIUM HYDROXIDE SOLUTIONS. Kass, S. (Bettis Atomic Power Lab., Pittsburgh). Corrosion, 25: 30-46(Jan. 1969).

An experimental technique for the controlled hydriding of Zircaloy-4 in concentrated lithium hydroxide solutions was developed. The procedure can be altered to yield uniform hydrogen distribution or to produce hydride rims. Zircaloy specimens must be insulated from all non-Zircaloy components to prevent spurious results. (auth)

12278 OXIDATION OF HCP ZIRCONIUM IN THE ELECTRON MICROSCOPE. Bigelow, W. C.; Hayes, W. J.; Allard, L. F.; Rowe, Anne (Univ. of Michigan, Ann Arbor). pp 302-3 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

The oxidation process is described and is illustrated by micrographs of Zr thin films exposed to O_2 under low pressure. (J.R.D.)

12279 KINETICS OF THE ATTACK OF RHENIUM BY ATOMIC AND DIATOMIC OXYGEN AT HIGH TEMPERATURES. Rosner, Daniel E.; Allendorf, H. Donald (AeroChem Research Labs., Inc., Princeton, N. J.). J. Chem. Phys., 49: 5553-5 (1968).

True oxidation kinetic data were obtained for the Re(s)/O(g) and Re(s)/O_2(g) reactions at surface temperatures from 700 to 3165°K, including an interval in which the oxidation rate decreases sharply with temperature, followed by a range of appreciable Re loss by direct sublimation. The existence of several regimes for both the Re(s)/O(g) and Re(s)/O_2(g) reactions, with the same ϵ (or Rh removal rate) being achievable at three distinct surface temperatures was noted. Results indicate that Rh loss at lower surface temperatures must be associated with the formation/desorption of volatile rhenium oxides. In this range, oxidation probabilities for O-atom attack are apparently oxygen-pressure independent (first-order reaction) whereas the O_2-attack probabilities tend to decrease with increasing p_{O_2} (fractional order) as found for the corresponding Mo(s) and W(s) reactions. (P.C.H.)

12280 EFFECT OF VARIOUS ELEMENTS ON HIGH-TEMPERATURE OXIDATION OF ZIRCONIUM AND ITS BINARY ALLOYS. De Gelas, B.; Beranger, G.; Lacombe, P. (Metallurgical Research Center, Paris). J. Nucl. Mater., 29: 1-26(Jan. 1969). (In French).

The influence of various additions (Cu, Cr, Fe, Mo, Al, NB, Sn) on the oxidation of zirconium at 750°C in oxygen has been examined, using thermogravimetry, micrography, electron microprobe analysis, x-ray diffraction, spectrographic analysis and a new method of oxygen analysis using a nuclear reaction. The oxidation kinetics include an initial stage with a complex kinetic law, a parabolic stage during which the oxidation rate is controlled by the diffusion of oxygen through the oxide film, and a stage of cracking and peeling. Certain additions, while not appreciably affecting the kinetics, are redistributed during oxidation: copper becomes enriched, chromium and molybdenum redissolved and iron is precipitated near the metal/oxide interface; only small concentrations of these elements are present in the oxide in solid solution or as inclusions. However, other elements (Al, Nb and Sn) greatly accelerate the oxidation of zirconium and are present in the oxide in amounts equivalent to their initial concentration in the alloy; cracking of the oxide accompanied by some formation of cubic zirconia is observed during a few hours' heating only. Results establish the Wagner-Hauffe theory inapplicable, and regard the solubility in the oxide of an additional element and the mechanical properties of the starting alloy as the important parameters in the oxidation of zirconium alloys. (tr-auth)

12281 PROCESSES OCCURRING DURING THE BREAKDOWN OF OXIDE FILMS ON ZIRCONIUM ALLOYS. Cox, B. (Chalk River Nuclear Labs., Chalk River, Ont.). J. Nucl. Mater., 29: 50-66(Jan. 1969).

The sequence of events occurring during oxide film breakdown on some zirconium alloys has been deduced by combining the use of a mercury porosimeter, designed to measure the size distribution of cracks and pores in insulating oxide films, with an electron microscope study of the same oxide films. The investigation has shown that the primary cause of the transition in the oxidation kinetics is the generation of a network of small pores (10 to 50 Å radius). These pores penetrate to the oxide/metal interface and no impervious barrier layer of oxide is apparent during post-transition oxidation. The occurrence of large cracks due to temperature cycling, or stresses generated by the film growth is a subsidiary and often minor contributor to the processes participating in oxide breakdown. They are probably the cause of cyclic post-transition oxidation, although not of transition itself. The small pores which lead to transition are thought to be generated by an oxide recrystallization process. (auth)

Preparation and Fabrication

Refer also to abstracts 12393 and 12395.

12282 METHOD OF AND APPARATUS FOR PRODUCING SMALL PARTICLES. (to Nuclear Materials and Equipment Corp.). British Patent 1,140,468. Jan. 22, 1969. Priority date Dec. 16, 1965, United States.

Apparatus and a method are described for producing small particles from a mass of larger bodies of metals such as Hf, Nb, Ta, Ti, and Zr and their alloys while maintaining minimum H, N, and O content. The bodies are subjected to mechanical forces while liquid Ar and N are continually injected into the bodies. (F.S.)

12283 MACHINED BODIES OF HIGH DENSITY HEAVY METAL ALLOYS. Goodfellow, Glenn Beattie; Kuzmick, Jerome Florian (to Powder Alloys Corp.). British Patent 1,139,051. Jan. 8, 1969. Filed Apr. 13, 1966.

Heavy metal alloys, based on a high tungsten content, are used for applications requiring a high mass in a small volume, e.g., for shielding against x-rays and other radiation. These alloys are usually required to be machinable and of high strength and good ductility. A machined body of a high density alloy is described, which is at least $\frac{1}{8}$ inch thick, and consists essentially of tungsten, nickel and iron, wherein the tungsten is present to between 80 and 99.9% by weight and the iron-nickel ratio is between 17:23 and 7:3 by weight. Preferably the iron present should exceed the nickel by less than 35% by weight. For some purposes it has been found advantageous to add up to 1% of cobalt to the alloy to increase the sintering temperature range and to stabilize the part during sintering. (UK)

12284 POROUS PERMEABLE MATERIALS OF NICKEL–MOLYBDENUM ALLOY. Sleptsova, N. P.; Solonin, S. M.; Chernyshev, L. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 12, 35-41(Dec. 1968). (In Russian).

Porous permeable materials were obtained from Ni–30 Mo alloy by means of sintering disperse powders with the application of fillers as well as by sintering granulated powders. Technology is developed for preparing two-layer filters from Ni–30 Mo alloy. (auth)

12285 THE PREPARATION OF FINE RECRYSTALLIZED TUNGSTEN WIRE FOR TRANSMISSION ELECTRON MICROSCOPY. Koch, E. F.; Walter, J. L. (General Electric Co., Schenectady, N. Y.). pp 362-3 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

Samples for use in studies of W wire properties for lamp filament were prepared in both annealed and drawn condition. The preparation and properties of the very fine wire specimens are described. (J.R.D.)

12286 PREPARATION OF METAL FOILS BY MECHANICAL REDUCTION. Carson, K. R. (Rice Univ., Houston, Tex.). pp 372-3 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

Preparation of foils by placing specimens on steel flat and hammering with a steel mallet is described. Samples of Ta, Ti, Pt, Fe, steel brass, Cu, Al, Cd, Sn, and Pb were prepared by this method. (J.R.D.)

12287 PROCEEDINGS [OF] TWENTY-FIFTH ANNIVERSARY MEETING, ELECTRON MICROSCOPY SOCIETY OF AMERICA, CHICAGO, ILLINOIS, AUGUST 29–SEPTEMBER 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967. 395p. (CONF-670819).

The abbreviated forms of 182 papers are included; separate abstracts were prepared for 8. The remaining papers include information on the use of electron microscopy in studies in histology, botany, virology, biology, pathology, cytology, films and surfaces, metals and alloys, crystals, and crystals and thin films, and instrumentation, high voltage instrumentation, and physical techniques for electron microscopy. (P.C.H.)

For abstracts of individual papers see: 11576, 12217, 12278, 12285, 12286, 12339, 12378, and 12434.

12288 AN APPARATUS FOR FLOATING ZONE MELTING OF REFRACTORY METALS BY ELECTRON BOMBARDMENT. Masumoto, Katashi; Tamura, Yoshio (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkaishi, 32: 1121-7(1968). (In Japanese).

An electron bombardment floating zone melting apparatus for refractory metals is described. The operation and the performance are further described for floating zone melting of W, Mo, Ta, Nb, Pt, Pd, and Fe rods. It was found that by using emission control, by which the bombardment current is kept constant by automatically adjusting the filament temperature and bombardment voltage, floating zone melting of sintered specimens was performed successfully. The purifying effect of floating zone melting was confirmed by residual resistance ratio measurements and, from the ratio values, it was made clear that the zone melted rods were purified by vacuum distillation and zone refining. By only one zoning, 5 mm ϕ W, Mo, Ta, Nb, Pt, and Pd rods were found to be single crystals at 1 ~ 4 mm/min without seed crystals. A 4 mm ϕ Nb single crystal was produced by using ⟨100⟩ seed crystals. This apparatus could be used as a single growing apparatus for refractory metals. (auth)

12289 GENERAL SITUATION OF NEW METAL INDUSTRY IN JAPAN IN 1968: ZIRCONIUM. Horikawa, Takeshi Shin Kinzoku, No. 49, 19-22(Sept. 1968). (In Japanese).

Zircon sand is a silicate ore of zirconium, and its consumption for molding sand is 36,000 tons a year. Six thousand tons of zirconium silicate are used yearly as a coloring agent for sanitary ware. The production of zircon fire bricks is about 17,800 tons in 1967. Oxides of zirconium are used in the electronics and glass industries, and organic compounds are utilized in accordance with their characteristics. Zirconium alloy is used for sheaths of nuclear fuel. Ordinarily, zirconium includes about 2.5% of hafnium, but the nuclear properties of hafnium are opposed to that of zirconium. Zirconium for reactor use requires removal up to 0.01% of the hafnium. The commercial grade does not require removal of hafnium. The most remarkable growth in the uses of zirconium was seen in its addition to iron and steel because it has strong deoxidizing, denitriding, dehydrogenizing and desulfurizing actions. The production and the state of use of reactor grade zirconium in Japan and the U.S.A. and its future prospects are described. (NSA of Japan)

12290 NICKEL-PLATING BATH FOR THORIUM. Wright, R. R. (to United States Atomic Energy Commission). U. S. Patent 3,419,419. Dec. 31, 1968.

A chemical reduction nickel-plating bath useful for plating nickel onto thorium surfaces contains: $NiSO_4$, 0.05 to 0.15 mole/l; $(NH_4)_2SO_4$, 0.3 to 0.6 mole/l; succinic acid, 0.05 to 0.30 mole/l; sodium acetate, 0.01 to 0.4 mole/l; and sodium hypophosphite, 0.2 to 0.5 mole/l. (AEC)

12291 DIFFUSION IN STABILIZED DELTA PLUTONIUM. 2. ALUMINUM. Tate, R. E.; Edwards, G. R.; Hakkila, E. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 29: 154-60(Feb. 1969).

Interdiffusion coefficients were measured on fcc low-aluminum (3.0 and 9.1 at. %) plutonium alloy couples annealed between 350 and 517°C. Concentration-penetration data obtained with an electron microprobe analyzer were fitted by a least-squares technique to give the following Arrhenius relationship $\tilde{D} = 2.25 \times 10^{-4} \exp[-25{,}500/RT]$ cm^2/sec. (auth)

12292 THE ELECTROLYSIS OF OXIDIZED SLAGS AND THE EFFECT OF SLAG-COMPOSITION ON THE CURRENT EFFICIENCY IN THE EXTRACTION OF VANADIUM AND TITANIUM. Lepinskikh, B. M.; Manakov, A. I.; Pankratov, V. A. Zh. Prikl. Khim., 40: 2743-6(1967). (In Russian).

The effect of slag-composition on the current efficiency for V production during the electrolysis of slags was studied. For a slag containing SiO_2 34.2, Al_2O_3 14.3, CaO 30.2, MgO 10.2, TiO_2 6.1, V_2O_5 1.5, FeO 1.0, S 0.9, and Cr_2O_3 0.2% at 1500°C, the current efficiency for the production of V and Ti was 46 to 63% and 9 to 11% respectively. Replacement of CaO in the slag by Al_2O_3 and SiO_2 reduced the current efficiency for V but had practically no effect on that for Ti, although additions of up to 5 to 7% K_2O significantly raised the current efficiency. With electrolysis of the binary systems $K_2O-V_2O_5$ and $CaO-V_2O_5$, the current efficiency was increased with increase in the K_2O and CaO contents of the respective melts. (Referativnyi Zh.)

Properties Evaluations

Refer also to abstracts 12372, 12988, 13397, 13398, 13407, 13499, and 13519.

12293 (AECL-3050) THE HARDENABILITY OF Zr-1.2 WT PERCENT Cr-0.1 WT PERCENT Fe. Rumball, W. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1968. 25p. Dep. CFSTI. CAN $1.00.

The behavior of the alloy Zr-1.2 wt% Cr-0.1 wt% Fe to quench hardening has been determined as a function of cooling rate from the quenching temperature. A maximum hardness of about 360 VPN occurs on cooling a 1400 ppM oxygen alloy at >2000°C/s, this hardness being unaffected by β quenching temperature, soaking time or β grain size. Cooling rates calculated using heat flow theory compared well with experimental data. The necessary heat transfer parameters are evaluated for this alloy and data are presented to enable the cooling rates of semi-infinite cylinders, sheets and thin-walled tubes to be calculated. These calculations enable the hardening response of these regular solids to be derived and in this way the cross-sectional hardness profiles of a range of fuel sheathing and pressure tubing sizes have been predicted. (auth)

12294 (AECL-3145) SWELLING OF THE CENTRAL BORAL DIVIDER PLATE OF AN IRRADIATED FUEL ROD SHIPPING BASKET. Judd, R. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1968. 20p. Dep. CFSTI. CAN $0.50.

Distortion of the central boral divider plate of an irradiated fuel rod shipping basket was observed after a routine shipment. The plate thickness, normally 1/4 inch, had increased to 1 1/2 inches. It was shown experimentally that the swelling was probably caused by steam formation within the plate. (auth)

12295 (AI-AEC-12721, pp 187-209) FUEL CLADDING AND STRUCTURAL MATERIALS. Shively, J. H. (Atomics International, Canoga Park, Calif.).

The effects of pressurized high-temperature NaK on the mechanical properties of Type 304 stainless steel tubes are described. (D.C.C.)

12296 (BNL-13079) ON THE SOLUBILITIES OF Cu, Ni, AND Fe IN LIQUID SODIUM. Singer, R. M.; Weeks, J. R. (Brookhaven National Lab., Upton, N. Y.). [1968]. 39p. (CONF-681106-12). Dep. CFSTI.

From Conference on Sodium Technology and Large Fast Reactor Design, Argonne, Ill.

The solubility of copper, nickel, and iron in sodium were measured. Copper solubilities in sodium were determined to range from 0.2 to 60 ppM at temperatures between 255 and 547°C. The solubility may be estimated by the following equation: $\log_{10}S$ (ppM Cu) = 6.91 − 4200/T(°K), over the temperature range 315 to 700°C. Nickel solubilities in sodium were completed at temperatures from 446 to 600°C. Results range from 0.6 to 1.8 ppM. The solubility may be calculated using the following equations: Ni(ppM) = 0.0046T(°C) −1.40, for the Ni content of the Na samples, and Ni(ppM) = 0.0076T(°C) − 2.76, which includes the Ni found on the samplers that can not as yet be considered as a contaminant. Iron solubilities in sodium were measured as a function of oxygen concentrations at 486 and 550°C The iron solubility increased with oxygen content above an oxygen activity of approximately 0.2. Early experiments from 370 to 450°C in systems containing 10 to 20 ppM oxygen indicated the iron solubilities were below detection limits. These lower limits varied from 0.05 to 0.1 ppM. (auth)

12297 (CONF-681031-1) STRESS-STRAIN BEHAVIOR OF RAPIDLY HEATED WROUGHT TUNGSTEN. Janowski, K. R.; Bohn, J. R. (TRW Systems Group, Redondo Beach, Calif.). [nd]. 27p.

From Fall Meeting of the Metallurgical Society of the AIME, Detroit, Mich.

The stress-strain behavior of extruded tungsten bar has been investigated from room temperature to 5150°F using unique electron beam heating and high speed data acquisition systems. These systems permit heating rates of approximately 1000°F/second and a data recording rate of 640 lines/second to be utilized to obtain the stress-strain behavior for wrought tungsten under conditions not previously investigated. A computer was used for the data reduction. The greatest differences in behavior noted between the present study and the published data for wrought tungsten were in those temperature ranges where the rates of recrystallization or grain growth were most rapid. In these temperature ranges, the observed yield strength exceeded that obtained on wrought tungsten tested at a slower rate than that used in the present study. Details of the testing systems, the observed mechanical behavior of wrought tungsten and the microstructural changes observed will be discussed. (auth)

12298 (CU-2660-36) HIGH-TEMPERATURE PROPERTIES OF THE ALKALI METALS. Lee, D. I.; Bonilla, C. F. (Columbia Univ., New York. Liquid Metals Research Lab.). Aug. 1967. Contract AT(30-1)-2660. 148p. Dep. CFSTI.

The viscosities of cesium, rubidium, potassium, and sodium vapors were measured up to 1000°C over a pressure range of 0.4 to 5 atm at maximum by a steady flow high-temperature coiled capillary viscometer. They were correlated with the mole fraction of dimer for convenient interpolation and extrapolation, on the basis that the alkali metal vapors are mixtures of monomer and dimer only. The "most-likely" potential energy curves for the singlet and triplet states of hydrogen atoms were constructed from the best data presently available, and were used to obtain those of the alkali metal atoms by a semi-empirical scaling procedure. The second and third virial coefficients were calculated from the scaled potential energies. The critical properties of the alkali metals were estimated by using the corresponding states relations based on the molecular constants and scaling factors. The potential energies for the dimer–dimer and monomer–dimer interactions were calculated by a semi-empirical pairing procedure. From the potential energies obtained the collision integrals were calculated and the transport properties were predicted as a function of temperature, pressure, and composition. (auth)

12299 (IS-Trans-78) THERMODIFFUSION OF ^{60}Co AND ^{63}Ni IN LIQUID METALS. Belashchenko, D. K.; Gruzin, P. L.; Zhuravska, V.; Kuleshevskaya, Z. M. Translated from Izv. Vyssh. Ucheb. Zaved., Chern. Met., 11: 5-8(1968). 4p. Dep. CFSTI.

Thermal diffusion of ^{60}Co and ^{63}Ni in liquid metals was studied by the capillary method in which the concentration distribution in a vertical tube with a given temperature gradient after thermodiffusion tempering is measured. The temperature dependence of the transfer heat of ^{60}Co and ^{63}Ni in liquid Pb, Bi, Sn, Cd, In, Tl, and Te at temperatures up to 800°C was determined. Cobalt and Ni migrate to the cold end of the specimen. The value of the transfer heat was usually 1 to 3 kcal/mol. Higher values were found for Te, and for Ni in Pb. (F.S.)

12300 (RD/B/N-1240) THE C AXIS TEXTURE OF ZIRCALOY-2 AND ZIRCONIUM-2.5 WT. PERCENT NIOBIUM PRESSURE TUBES. Waterman, N. A.; Hesketh, R. V. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 5p. Dep.

The c-axis texture was measured in pressure tubes of cold worked Zircaloy-2, and Zr–2.5 wt % Nb before and after heat treatment. The measurements show that heat treated Zr–Nb tubes have the greatest dimensional stability against granular radiation growth. Cold worked Zircaloy is a little better than untreated Zr–Nb, but both are worse than heat treated Zr–Nb. (auth)(UK)

12301 (TRG-Report-1269) FRICTION AND WEAR BEHAVIOUR OF SLIDING BEARING MATERIALS IN SODIUM ENVIRONMENTS AT TEMPERATURES UP TO 600°C. Roberts, W. H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). May 1966. 41p. Dep. CFSTI. UK.

Friction and wear data, obtained with a crossed-cylinders apparatus, are presented for a selection of molybdenum–tungsten–chromium alloys, over the temperature range 200 to 600°C, for two sodium environments: the molten metal, containing approximately 5 ppM of oxygen impurity; and pure argon containing sodium vapor at concentrations corresponding with the temperature equilibrium value. Some comparisons are made with results obtained in gaseous environments of pure argon and carbon dioxide. An indication is given of the effect on friction and wear behavior of increasing the oxygen content in liquid sodium, from about 5 to 80 ppM. It is concluded that chemisorbed double-oxide films, formed by reaction of the molybdenum, tungsten, chromium and, possibly, iron constituents of the alloys with the sodium environment, play a significant role in providing boundary lubrication in high-temperature sodium. Additionally, the effectiveness of the lubrication provided by such films is a function of the specific nature of the sodium environment (vapor or molten state), and of temperature, as well as time at temperature. Another source of boundary lubrication considered to have been operative, more especially with cobalt- and nickel-base spray-fused hard-facing alloys, were compounds of (minor) constituents of these alloys which had intrinsic anti-friction and anti-wear properties and whose efficacy does not primarily depend on reaction with sodium. (auth)

12302 (WARD-3791-26) STAINLESS STEEL CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1968. Bleiberg, M. L. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct. 1968. Contract AT(30-1)-3791. 41p. Dep. CFSTI.

Authorizations, availability, and funding are established for the Type 316 austenitic stainless steel development program. Characterization studies have begun on commercial grade, air-melted, solution-annealed tubing to be used as cladding in LMFBR fuel pins. Optical microscopy showed normal inclusion precipitation. Substructural characterization includes grain size, precipitation and inclusion distribution, x-ray diffraction studies of the precipitates, transmission electron microscopy of the dislocation arrangement, and electron beam microanalysis of the precipitated particles. Results show that the tubes have a higher dislocation density than expected, indicating that the tubes have been subjected to slight deformation after the recrystalline heat treatment. The outer surfaces of these tubes are heavily cold worked up to a depth of one mil due to a final surface grinding operation. (J.C.W.)

12303 THE DIAGRAM OF STATE OF SYSTEM Nb–Be. Raevskii, I. I.; Grigor'ev, A. T. Izv. Akad. Nauk SSSR, Metal, No. 5, 198-202(Sept.-Oct. 1968). (In Russian).

Microstructure, x-ray structure, and phase analyses were made on the hardness and microhardness of cast and sintered Nb–Be alloys with up to 50 wt % Be. Phase diagrams were made of the Nb–Be alloys. Diffusion of Be in Nb at 700 to 1400°C was studied by x-ray analysis. A maximum Be diffusion in Nb was observed at 1590°C and was comprised of about 1.8 wt %. Four intermediate phases according to stoichiometric composition Nb_3Be_2 $NbBe_2$, $NbBe_3$, and $NbBe_5$ were found. The reactions between all compounds were of eutectic character. The compound Nb_3Be_2 was formed according to peritectic reaction at 1590°C. Microhardness of the compounds Nb_3Be_2, $NbBe_2$, $NbBe_3$, and $NbBe_5$, was equal to 760 to 800, 1600, 1330, and 1570 kg/mm^2, respectively. (P.C.H.)

12304 COMPATIBILITY OF MATERIALS. Kohl, Walter H. (Electronics Research Center, Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Spectrum, 6: 67-74(Jan. 1969).

The success of space-age endeavors depends greatly upon the materials used to construct a certain module, part, or subsystem, and the interaction between these materials and their immediate environment. A metal, for example, must retain its physical integrity in shape, ductility, and tensile strength over stringent stress and temperature ranges; it must be able to withstand proximity with other materials, metallic and nonmetallic, while maintaining chemical stability. Nonmetallic materials must be compounded to prevent such reactions as outgassing or decomposition at high altitudes; others, such as ablative ceramics, must disintegrate in a certain manner. In short, the demand for more specialized, more durable substances has created a new materials technology. (auth)

12305 THE EFFECTS OF PROCESSING CONDITIONS ON THE MAGNETIC AND SWITCHING PROPERTIES OF FINE MO-PERMALLOY RIBBON AND TWISTER. Ichinose, Yukio; Yamashita, Takeo; Taniguchi, Satoshi; Hishiyama, Sadao; Kobayashi, Masaru (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 1137-42(1968). (In Japanese).

The effects of processing conditions on the magnetic and switching properties of a fine Mo-permalloy ribbon and a twister were investigated. Magnetic and switching properties of the ribbon and the twister are influenced by these processing conditions, especially by the degree of cold reduction and the aging in the fine wire before cold rolling to the ribbon. The higher degree of cold reduction in the process and the lower aging temperature in the process result in the better magnetic and switching properties of the ribbon and the twister. The processing conditions influence the roll-anisotropy and dispersion relating to the magnetic and switching properties of the ribbon and the twister. In the twister, it was found that aging in the ribbon before winding and stabilizing the twister after winding are both important to magnetic and switching properties. (auth)

12306 DISLOCATION SUBSTRUCTURE FORMED DURING CREEP IN MOLYBDENUM SINGLE CRYSTALS. Clauer, Allan Henry. Columbus, Ohio, Ohio State Univ., 1968. 309p.
Thesis.

Single crystals of molybdenum were subjected to tensile creep from 0.5 to 0.76 T_m in vacuum where T_m is the absolute melting temperature. The tensile axis was parallel to the [011] direction. The activation energy for creep was 106 kcal/mol measured in constant stress isothermal creep tests at two tensile stresses, 900 psi (0.63 kg/mm^2) and 2000 psi (1.41 kg/mm^2). This is in agreement with the reported values for the activation energy for self-diffusion (93 to 115 kcal/mol). Primary creep extended up to 0.46 tensile strain, the highest creep strain measured, although the creep rate was approaching a constant value at this strain. The dislocation substructure was investigated after strains of 0.01, 0.02, 0.05, 0.22, and 0.42 at 900 psi and 1650°C using the Laue back reflection x-ray technique, etch pitting, and transmission electron microscopy. Extensive transmission electron microscopy studies were also made on specimens crept to various strains at 2000 psi and 1410°C. The primary mode of deformation was slip on the two symmetrical (211)[111] slip systems. Immediately after loading, the substructure is composed of alternating bands of high and low relative dislocation density. The dislocations in the bands of high dislocation density are arranged in diffuse rows which are probably diffuse tilt walls. Neither slip bands nor dislocation pileups have been observed in the creep substructure and the background dislocation density is uniform. The nonuniformity of the creep strain illustrated by the coarse surface slip bands is related to the banded substructure that forms during creep. The actual rate-controlling mechanisms cannot be identified but several current creep theories can be shown to be inapplicable. The substructure is composed primarily of edge dislocations which rearrange themselves into tilt walls. Network boundaries are present but are not as numerous as tilt boundaries. No dislocation pileups have been observed. These observations eliminate the drag-jogged screws and climb of edge dislocations from pileups as rate-controlling mechanisms. Beginning immediately after loading the structure recovers continuously with increasing strain. Hence, work hardening is not the cause of the decreasing creep rate during primary creep. (TSS)(Disser. Abstr.)

12307 NUCLEAR METHODS FOR DETERMINATION OF IMPURITIES ON THE SURFACE OF METALS. APPLICATION OF ZIRCONIUM. Amsel, G. (Laboratoire de Physique, Paris); David, D.; Beranger, G.; Boisot, P.; De Gelas, B.; Lacombe, P. J. Nucl. Mater., 29: 144-53(Feb. 1969). (In French).

A method is described for surface analysis of metals, which permits the estimation of various elements such as O, N, C, Si, and S. The method was developed to study the effects of impurities resulting from polishing zirconium and its alloys. It is possible to estimate the thickness of the contaminated layer (whether by formation of an oxide film or by dissolution of interstitial oxygen in the metal) when Zr is polished in fluoronitrate baths and to observe the trapping of appreciable amounts of O as a result of various mechanical treatments. Inclusion of abrasive particles was also examined. The use of this technique for other metals is discussed. The various observations show the utility of this method for preparing surfaces for subsequent physical or chemical studies, such as oxidation kinetics. (auth)

12308 ELECTRON MICROSCOPE OBSERVATIONS OF LIQUID SODIUM INTERACTION WITH 304 STAINLESS STEEL. Moberly, J. W.; Barlow, M.; Garrison, M. C.; Planting, P. J. (Stanford Research Inst., Menlo Park, Calif.). J. Nucl. Mater., 29: 223-8(Feb. 1969).

The nature and extent of the interaction of 304 stainless steel with high purity liquid sodium at 650°C were investigated using thinned stainless steel foils exposed to Na in a small 5 cm in dia by 10 cm high furnace operating in a vacuum. The foils showed Na attack at the edges, grain boundaries, and precipitation on the surfaces and at the grain boundaries. Differences in the appearance of precipitate deposits suggest that more than one compound could be involved. (F.S.)

12309 DIFFUSION OF HYDROGEN UP A THERMAL GRADIENT IN ZIRCALOY-2. Wilkins, B. J. S.; Wasylyshyn, A. (Atomic Energy of Canada Ltd., Manitoba). J. Nucl. Mater., 29: 235-7(Feb. 1969).

In demonstrating that a maximum temperature gradient is not a barrier to the thermal diffusion of H in Zircaloy-2, a Zircaloy-2 rod was machined into two pieces and friction welded together after the smaller piece was hydrided to 2000 ppM. A thermal gradient was maintained on the rod using alternate heat sinks and heating elements. The terminal solubility of H in Zircaloy-2 and the final H distribution was found. The maximum in the temperature gradient did not prevent H from reaching the cold end of the Zircaloy-2, but it did influence the distribution. Two separate two-phase regions were produced, one in the vicinity of the temperature minimum and one adjacent to the cold end of the rod. (F.S.)

12310 STUDY ON THE STAINLESS STEELS FOR FAST REACTORS. 2. ON THE CREEP FRACTURE STRENGTHS OF AUSTENITIC STEELS OF 304 AND 316 SERIES WITH DIFFERENT CARBON CONCENTRATIONS. Yoda, Renpei; Yoshida, Heitaro Tetsu To Hagane, 54: 289(Aug. 1968). (In Japanese).

The effects of carbon on the creep fracture characteristics, the resistances to softening, and the changes in lattice constants of austenitic steels of 304 and 316 series were investigated. Every material showed hardening by heating at the temperature below the beginning point of softening, and the amount of hardening increased with the increase of carbon content. In case of heating at 450 to 1150°C, the temperature $T_{1/2}$, at which the mean hardness number of the highest hardness and the hardness at 1150°C was shown, indicated a peak in the vicinity of 0.2% carbon for both series of steels, and it was improved by Mo. The relation between the degree of working and the hardness of the rolled material followed the parabolic law. The creep fracture stress showed a peak in the vicinity of 0.3% carbon in case of 316 series steel at 600°C for 1000 hours, but the peaks appeared in the vicinity of 0.2% carbon for the other conditions. The peak of the creep fracture strength is considered to be due to the solid solution strengthening and the precipitation strengthening of carbon, and it is explained by the fact that $T_{1/2}$ is highest. (NSA of Japan)

12311 STUDY ON THE STEEL FOR PRESSURE VESSEL OF NUCLEAR REACTOR. 2. THE EFFECT OF MANY HOURS HEATING ON LOW CYCLE FATIGUE OF A302B STEEL. Hasegawa, Masayoshi; Sano, Masayuki (Waseda Univ., Japan). Tetsu To Hagane, 54: 210(Aug. 1968). (In Japanese).

Blocks of A302B steel were heated for 1000 hours at 300, 350, and 400°C. Fatigue, hardness, tensile, Charpy impact tests, and observations of metallic structures were conducted. The testing temperatures were room temperature, 300 and 400°C. After many hours heating, elongation and reduction of area in tensile test decreased, while transition temperature in impact test rose, compared with these values before heating. In spite of comparatively low temperature heating, cohesion of carbide was observed at grain boundaries heated to 1000 hours. The change in material strength was due to the change in metallic structure. The fatigue test was carried out on these heated materials, and their lives up to fatigue fracture extended more than before heating. The trend of life extension was most evident at 400°C heating. The life up to low cycle fatigue fracture in the operation of nuclear reactor is longer than the test result at room temperature, but brittleness of the material results. (NSA of Japan)

12312 THE PRECIPITATION HARDENING OF ALLOYS OF Fe-Nb AND Fe-Zr SERIES WHICH DO NOT CONTAIN CARBON. Hasegawa, Masayoshi; Okamoto, Masabumi (Waseda Univ., Japan). Tetsu To Hagane, 54: 382-5(Aug. 1968). (In Japanese).

The effects of third elements on precipitation hardening and the mechanism of precipitation hardening were investigated in Fe-Nb and Fe-Zr alloys. For the third elements, Al, Si, P, Cr, Mn, Co, Ni, Cu, Mo, and W were selected, and 0.3 to 5% of them were added to the alloys. The samples in solution were aged at 500 to 650°C, and the aging process was studied by the measurements of hardness numbers, microscopic structures, and lattice constants. X-ray diffraction testing of the electrolytically extracted residue and the fixing of the precipitates by EPMA of bulk samples were carried out. The phenomenon of precipitation hardening was observed by the aging treatment of the supersaturated solids of Fe-Nb and Fe-Zr alloys which did not contain carbon, and the binary alloys hardened by the scattered precipitation of Fe_2Nb and Fe_2Zr of Laves phase. By addition of the third elements, the precipitation of Fe_2Nb was observed in Fe-Nb alloy, and the third elements accelerated the precipitating speed by affecting the nucleation of Fe_2Nb, and increased the precipitation hardening. In the Fe-Zr alloy, the other Zr compounds in addition to Fe_2Zr were precipitated by addition of the third elements, and the precipitation behavior was complicated. In the alloy with Fe_2Zr precipitation, the precipitation hardening due to this compound was accelerated by the third elements. (NSA of Japan)

12313 EFFECT OF DENSITY ON THE THERMAL CONDUCTIVITY OF URANIUM DIOXIDE. Asamoto, R. R.; Anselin, F. L.;

Conti, A. E. (General Electric Co., Sunnyvale, Calif.). Contract AT(04-3)-189. J. Nucl. Mater., 29: 67-81(Jan. 1969).

The thermal conductivity of 82, 86, 91 and 95% theoretical density (T.D.) sintered uranium dioxide has been measured by the radial heat flow technique, between 800 and 2000°C in an argon atmosphere. The data indicate that use of the simplified Loeb or Maxwell-Eucken equations, or currently recommended modifications of these thermal conductivity-density relationships are not applicable for the temperature, temperature gradient, and density ranges investigated. Thermal conductivity values for uranium dioxide were related to both temperature and density by the equation $k = 0.0130 + \{T(0.4848 - 0.4465D\}^{-1}$, [W/cm · °C], for temperatures between 800 and 2000°C and densities between 82 and 95% T. D. (T = temperature in °C, and D = density in fraction of theoretical). The time required for microstructural and/or density changes to occur in oxide fuel elements under irradiation is generally short relative to the total exposure time. Because the thermal conductivity of a typical oxide fuel has been found to be quite dependent on density in this investigation, a model utilizing the relationships derived is described in which thermal conductivity and $\int kdT$ curves corrected for fuel densification occurring in-reactor can be generated. (auth)

12314 INTERNAL FRICTION IN ZIRCONIUM–HYDROGEN ALLOYS AT LOW TEMPERATURES. Povolo, F.; Bisogni, E. A. (Comision Nacional de Energia Atomica, Buenos Aires). J. Nucl. Mater., 29: 82-102(Jan. 1969).

Using a low-temperature torsion pendulum, internal friction measurements have been performed in polycrystalline wires of high purity zirconium charged with hydrogen up to 56 at. %. The internal friction spectrum shows three peaks in the temperature range between −195 and 120°C. The mechanisms proposed to explain each of the peaks differ fundamentally from those previously proposed, and it has been found that the heights of the peaks change with time, even though the hydrogen concentration in the samples remains constant. A metallographic study of the wires has been made in order to correlate the internal friction results with the distribution and quantity of the several phases in the sample. (auth)

12315 TUNGSTEN NEWS, DECEMBER 1968. New York, Climax Molybdenum Co., 1968. 18p.

Properties of tungsten metals are reviewed. A new process of spraying tungsten for coating applications is presented along with information on nuclear applications, and surface phenomena. The total neutron cross section of W has been measured between 5.3 and 6.3 MeV. Research and applications of tungsten carbides are reported. Tungsten alloys and tungsten as an alloying element are discussed for research and commercial applications. A summary of uses and applications of tungsten compounds including chlorides, oxychlorides, hexafluorides, trioxides, tungstates, disilicides, and disulfides is given. A listing of 186 references is included. (J.C.W.)

12316 ELECTRICAL AND THERMAL CONDUCTIVITIES OF METALS OVER THEIR ENTIRE LIQUID RANGE, i. e., FROM MELTING POINT TO CRITICAL POINT, AND THE CONTAINMENT OF METALLIC SUBSTANCES UP TO 5000°K FOR SUBSTANTIAL PERIODS OF TIME. Grosse, Aristid V. (Centre National de la Recherche Scientifique, Paris). Rev. Hautes Temp. Refract, 3: 115-46(1966).

A summary of electrical and thermal conductivities of metals at high temperatures is given. Heating metallic substances to high temperatures involves heating by electrical ohmic resistance. The electrical conductivity and thermal conductivity of liquid Hg was measured over the liquid range, and a partial range of liquid Cs, K, Na, and Rb is available. Electrical and thermal conductivities of Ag, Au, and Cu are tabulated. Research data are reported on liquid Fe, Li, Mo, Nb, Re, Sn, Ta, W, Zn, and rare earth metals. Determinations of rates of sublimation of graphite under liquid tantalum carbide were made. Experiments and procedures are described. (J.C.W.)

12317 SCALING CONDITIONS OF URANIUM AND A URANIUM–MOLYBDENUM ALLOY. Vacellier, J.; Verdes, G.; Legrand, J. (CEA, Sevran, France). pp 251-62 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968. (In French).

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

Results of the investigation and theoretical considerations indicate that the rupture tension value is 200 to 250 kb when the relaxation velocity is on the order of Mb/μsec. The high rupture value can be reconciled if metal fracture is considered in conjunction with values for interatomic binding energies in the crystals. A tension at rupture of 200 kb is the proper range for use as the limit of quantities used in models. Agreement in values for Al and brass is noted. (tr-auth)

12318 EVALUATION OF THE ELASTIC LIMIT OF COPPER AND URANIUM BY SLOW IMPLOSION EXPERIMENTS. Verney, D. (Centre d'Etudes de Gramat, Lot, France). pp 293-303 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968. (In French).

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

An exploratory study was conducted to develop a valid measurement of residual deformation related to the metal specimen temperature after recovery from incomplete implosion. Data were obtained on initial kinetic energy and internal energy in the metal samples at the conclusion of implosion. A model was developed of the elastic-plastic flow that is expected to allow better precision and less data dispersion in average metal studies. (tr-auth)

12319 Zr Hf NEWSLETTER, JANUARY 1969. Akron, N. Y., AMAX Specialty Metals, Inc., 1969. 16p.

The properties and applications of hafnium and its alloys and compounds are discussed. Zirconium, zirconium-base alloys, and zirconium as an alloying addition are discussed. The research on borides, carbides, hydrides, nitrides, and oxides of hafnium and zirconium is summarized. A listing of 192 references is given. (J.C.W.)

12320 GADOLINIUM–LEAD SYSTEM. Demel, J. T.; Gschneidner, K. A. Jr. (Ames Lab., Iowa). J. Nucl. Mater., 29: 111-20(Jan. 1969).

The gadolinium-lead binary phase diagram has been determined by differential thermal analysis, metallographic and x-ray methods. The addition of lead to gadolinium lowers the α-β transformation from 1258 to 1212°C by an inverted peritectic transformation. Gadolinium additions to lead raise its melting temperature by a peritectic transformation from 327 to 328°C. The room temperature solid solubility is negligible for the pure materials. A eutectic transformation occurs at 14.5 at. % Pb and 1120°C. There are six intermetallic compounds. Gd_5Pb_3 melts congruently at 1670°C and Gd_5Pb_4, $Gd_{11}Pb_{10}$, Gd_6Pb_7, $GdPb_2$ and $GdPb_3$ all melt peritectically at 1460, 1225, 1160, 1010, and 969°C, respectively. In addition there is a polymorphic transformation in Gd_5Pb_4 at 1410°C. The crystal structures and lattice parameters for Gd_5Pb_3, Gd_5Pb_4 and $GdPb_3$ are: Gd_5Pb_3, hexagonal Mn_5Si_3 ($D8_8$) type, a_0 = 9.078 ± 0.004 Å and c_0 = 6.644 ± 0.005 Å; Gd_5Pb_4, pseudo-tetragonal Sm_5Ge_4 (Pnma-D_{2h}^{16}) type, a = c = 8.20 ± 0.01 Å and b = 15.62 ± 0.02 Å; and $GdPb_3$, cubic $AuCu_3$ ($L1_2$) type, a_0 = 4.8261 ± 0.0007 Å. The crystal structures for the other intermetallic compounds are not known. (auth)

12321 PHOSPHORUS DIFFUSION IN NIOBIUM AND MOLYBDENUM. Vandyshev, B. A.; Panov, A. S. Fiz. Metal. Metalloved., 26: 517-21(Sept. 1968). (In Russian).

Intralayer radiometric analysis with a radioactive ^{32}P isotope was used for determining diffusion of phosphorus into Nb and Mo at temperatures from 1300 to 1800°C and 2000 to 2200°C, respectively. Correlations of obtained theoretical and experimental data on the magnitudes of D_0 and Q indicated the possibility of intracrystalline lattice mechanism of phosphorus atom diffusion in the metals. (tr-auth)

12322 THERMAL CONDUCTIVITY OF MOLYBDENUM THICK FILMS ON BERYLLIUM OXIDE. Cole, Sandford S. Jr. (Mitronics, Inc., Murray Hill, N. J.). Amer. Ceram. Soc. Bull., 47: 806-9(Sept. 1968).

The cut-bar in vacuum technique was modified to study the thermal conductivity of thick Mo films on Be oxide. Films containing 78 and 89% Mo were measured at 60 to 130°C after sintering at 1260 and 1370°C. The effects of sintering temperature, Mo content, and test temperature were examined. A value of thermal conductivity for 78 and 89% Mo thick films on Be oxide of 0.05 cal/sec°C/cm²/cm was established for the films in the test range of 60 to 130°C. The value appeared to be independent of temperature over this range. Higher film sintering temperatures tended to produce higher thermal conductivity values, but the increase is modest. Increases in Mo content may increase thermal conductivity, but such increases could not be conclusively determined in this study. (BBB)

12323 APPLICATION OF RADIOACTIVE ISOTOPES IN SOME STUDIES IN POWDER METALLURGY AND TO PHOSPHORS. Danneberg, W. pp 267-80 of Technisch-Wissenschaftliche Abhandlungen der Osram-Gesellschaft. Band 9. Lompe, Arved (ed.). Berlin, Springer-Verlag, 1967. (In German).

Radioactive isotopes have been used for the solution of technological problems in many areas. The application to the grain size analysis of metal and phosphor powders by sedimentation is considered. The quantitative determination of small sodium concentration in calcium phosphates and calcium fluoride and the density measurement along tungsten rods and in briquets were given as specific examples. The examples show that studies with radioisotopes have significant advantages over other methods. (tr-auth)

12324 EXAMINATION OF THE THERMAL RESISTANCE AND STABILITY OF Al-3 PERCENT Mg ALLOY TUBES FOR NUCLEAR APPLICATIONS. Beghi, G.; Henry, B.; Nasi, M. (EURATOM CCR, Ispra, Italy). Met. Ital., 60: 883-90(Oct. 1968). (In Italian).

The structural stability of an Al−3% Mg alloy tube was studied with respect to the possibility of its use under conditions of thermomechanical stresses. Thermal fatigue tests and thermal treatments at 420°C were made for durations up to 5000 hrs; the effects of these stresses on the structure and properties were verified by metallographic determination of the grain size and tensile tests at 20 and 400°C. Good stability was established. The secondary recrystallization was induced and studied at temperatures above 500°C; it was possible to determine an activation energy for this phenomenon which has confirmed the thermal stability of the material. (tr-auth)

12325 TECHNISCH-WISSENSCHAFTLICHE ABHANDLUNGEN DER OSRAM-GESELLSCHAFT. BAND 9. (Technical-Scientific Transactions of the Osram Society. Volume 9). Lompe, Arved (ed.). Berlin, Springer-Verlag, 1967. 374p.

Separate abstracts were prepared for four papers. An additional 24 papers on various aspects of luminescence and photometry are included. Author and subject indexes are included. (H.L.W.)

For abstracts of individual papers see: 12235, 12323, 12326, and 12366.

12326 RESIDUAL RESISTANCE OF TUNGSTEN WIRES FOR LUMINOUS BODIES IN RELATION TO ANNEALING AND ELECTROLYTIC EROSION. Gemas, H.; Hamel, H.-J. pp 149-56 of Technisch-Wissenschaftliche Abhandlungen der Osram-Gesellschaft. Band 9. Lompe, Arved (ed.). Berlin, Springer-Verlag, 1967. (In German).

The effect of annealing on the residual resistance of enriched tungsten wires for luminous bodies with initial diameter of 0.20 mm and after electrolytic erosion 0.13 mm was investigated. After annealing in the temperature range from 1700 to 2000°C, in which no recrystallization occurred, the initial wires showed a residual resistance decreasing with increase of temperature and prolongation of the annealing time. With the introduction of recrystallization over 2000 °C, the residual resistance decrease was accelerated and decreased after extended annealing to a given end value dependent on the annealing temperature. From the measurements of the residual resistance changes of eroded wires, it was shown that in unannealed wires regions of higher deformation stresses exist, which were decomposed in annealing at temperatures up to ~2000°C more sharply than the boundary layers. The increase of the residual resistance after annealing over ~2400°C with increasing pitting was attributed to a preferable purification of the boundary layer in the evaporation of the admixtures. (tr-auth)

12327 INFLUENCE OF URANIUM ON THE PROPERTIES OF GRAY IRON. Tsutsumi, Nobuhisa; Miura, Toshio. (Waseda Univ., Tokyo). Rep. Cast Res. Lab., Waseda Univ., No. 17, 41-55(1966).

The effect of U alloying on the properties, particularly microstructure and mechanical properties of high-S and low-S gray iron was investigated. Alloying did not affect properties at the transformation temperature or during thermal expansion of U segregation. The chill depth in high-S iron, however, is at first decreased by U additions, because of the affinity of U to S, but gradually increases with higher U additions. The type of graphite changed to abnormal mesh type by higher U addition. Uranium has a powerful effect on the hardness rather than on the tensile properties of gray iron. No obvious variation of the corrosion resistant property in nitric, hydrochloric, and sulfuric acid was observed. (Rev. Metal Lit.)

Structure and Phase Studies

Refer also to abstracts 11733, 12287, 12303, and 12304.

12328 (COO-1778-1) A STUDY OF GRAIN BOUNDARY SEGREGATION USING THE AUGER ELECTRON EMISSION TECHNIQUE. Annual Technical Progress Report: I. Stein, D. F.; Ramasubramanian, P. V. (Minnesota Univ., Minneapolis. School of Mineral and Metallurgical Engineering). Dec. 26, 1968. Contract AT(11-1)-1778. 11p. Dep. CFSTI.

The system to induce fractures in vacuum at low temperatures, to sputter the surface produced, and do Auger Electron Emission analysis of the fractured surfaces or sputtered surfaces has been designed and is now operating. The initial studies will be on a group of several pure metals so the unit can be calibrated in respect to the spectra of the various elements and then we will proceed with the analysis of grain boundary fractures of iron base alloys. (auth)

12329 (IS-T-264) A THERMODYNAMIC STUDY OF PHASE STABILITY IN THE TRANSITION-METAL RICH PHASES OF THE THORIUM-IRON, THORIUM-COBALT, AND THORIUM-NICKEL SYSTEMS AND THE COPPER RICH PHASES OF THE THORIUM-COPPER SYSTEMS. Magnani, Nicholas J. (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 51p. Dep. CFSTI.

Solid electrolyte electromotive force cells have been used to determine the free energies, entropies and enthalpies of formation of several thorium-poor phases in the binary systems of thorium with iron, cobalt, nickel, and copper. These phases were Th_2Fe_{17}, Th_2Co_{17}, $ThCo_5$, Th_2Ni_{17}, $ThNi_5$, $ThNi_2$, and $ThCu_4$. The electrolyte which was used in the cells was CaF_2 which is an ionic conductor over the temperature range of the measurements (600 to 850°C) and over the range of partial pressures of fluorine encountered in this investigation. The cells were of the type: Th, $ThF_4|CaF_2|ThF_4$, M, ThMx; Th, $ThF_4|CaF_2|ThF_4$, Th_2M_{17}, ThM_5, and Th, $ThF_4|CaF_2|ThF_4$, ThM_5, ThM_2 where M equals iron, cobalt, nickel, and copper for Equation 1, cobalt and nickel for Equation 2, and nickel for Equation 3. The data indicate a decreasing stability of equivalent intermediate phases in the Th−M systems from nickel to cobalt to iron. The data also suggest there is a correlation between crystallographic data and thermodynamic data for these phases and that interactions between thorium and the nearest neighbor transition metals are the dominant interactions stabilizing these phases. (auth)

12330 (NYO-3789-6) OBSERVATIONS RELATED TO THE ORDER OF THE LOW TEMPERATURE STRUCTURAL TRANSFORMATION IN V_3Si AND Nb_3Sn. Mailfert, R.; Batterman, B. W. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering); Hanak, J. J. (Radio Corp. of America, Princeton, N. J. RCA Labs.). [1968]. 7p. Dep. CFSTI.

Any volume change associated with the low-temperature cubic to tetragonal transformation in V_3Si and Nb_3Sn was found to be less than 0.05%, which is the order of experimental error. (auth)

12331 PHASE TRANSFORMATIONS IN La. Amonenko, V. M.; Pavlov, V. C. Izv. Akad. Nauk SSSR, Metal, No. 5, 212-14(Sept.-Oct. 1968). (In Russian).

Studies were made on the phase transformation of La of different purity. In pure La only three transformations were observed: $\alpha \rightarrow \beta$ at 320 ± 2°C; $\beta \rightarrow \gamma$ at 880 ± 2°C; and the melting point of the metal. In the polymorphic transformation $\alpha \rightleftharpoons \beta$ considerable hysteresis is inherent to $\beta \rightarrow \alpha$ polymorphous transformation at 200°C and is not completed until it reaches room temperature. The ratio of phases (α and β) in La at room temperature is a function of the purity of the metal. The amount of α phase increases with an increase in the purity of La. (P.C.H.)

12332 CONTRIBUTION TO THE STUDY OF THE ζ COMPOUND IN THE Pu−Th SYSTEM. Marcon, J. P.; Portnoff, A. Y. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 28: 341-4(1968). (In French).

Studies were made to determine the exact density and to index the x-ray diagram of the ζ compound in the Th−Pu system. Density measurements by hydrostatic displacement in bromobenzene on samples with different at. % of Pu gave a density value for ζ above 15.32 ± 0.03. The real density of this compound was determined from an extrapolation from the total density of an alloy with 62.93 at. % Pu. The value obtained was 15.39 ± 0.05. The crystalline parameters of ζ were measured. The values $a = 6.22 \pm 0.02$, $b = 11.62 \pm 0.30$, and $c = 7.09 \pm 0.02$ Å were proposed on the hypothesis of an orthorhombic lattice. It is concluded that ζ probably has the formula Pu_7Th_3. (J.S.R.)

12333 EFFECT OF TUNGSTEN ON PHASE TRANSFORMATIONS IN NICKEL-BASE ALLOYS. Havalda, Andrej (UFK-SAV, Bratislava). Kovove Mater., 5: 483-95(1967). (In Czech).

The effect of W in the Ni−Cr−Ti−Al system at 850°C was studied. Increasing the W content in this system retards transformation of the metastable γ'-phase (Ni_3Ti) into the stable η-phase (Ni_3Ti). Under the given test conditions (after homogenization at 1200°C for 150 hr in air) in vacuum $<10^{-2}$ torr and annealing at 850 ± 3°C for 0 to 1000 hr) the $\gamma' \rightarrow \eta$ transformation took place through continuous and discontinuous precipitation. The cause of the hardening of the alloys alloyed with Ti is the presence of the metastable fcc γ'-phase, which has a substantially greater hardening action than the stable hexagonal η-phase. Increasing the W content in alloys, where Ti : Al < 1 accelerates the $Cr_7C_3 \rightarrow Cr_{23}C_6$ transformation. (F.S.)

12334 METALLOGRAPHIC EXAMINATION OF ZIRCONIUM DEPOSITED ON GRAPHITE. Gravetskii, G. A.; Poso'eva, G. D. Weld. Prod. (USSR) (Engl. Transl.), 15: 27-30(Feb. 1968).

Translated from Svar. Proizv., 15: 27-30(Feb. 1968).

Zirconium was deposited on graphite with a non-consumable electrode in argon. The effects of oxygen and nitrogen on the structure of the deposited metal are indicated. (auth)

12335 TEMPERATURE DEPENDENCE OF THE DISLOCATION INTERACTION IN NIOBIUM. Arndt, Renate (Univ., Goettingen, Ger.). Z. Metallk., 60: 29-37(Jan. 1969). (In German).

The influence of thermally activated processes on the interaction of dislocations and on the temperature dependence of the flow stress in bcc metals was investigated by correlating the flow stress τ of niobium single crystals which had been compressed dynamically in steps at 228, 295, and 523°K with the dislocation density ρ. τ may be described as a function of ρ as $\tau = \tau_R + aGb\sqrt{\rho}$. The constant a of the dislocation interaction is temperature dependent and passes through a minimum at room temperature. The friction stress τ_R decreases with temperature and reaches zero at 523°K. (auth)

12336 INFLUENCE OF SUPERIMPOSED DEFORMATION ON THE PRECIPITATION OF THE ϵ-PHASE IN AN IRON–MOLYBDENUM ALLOY. Uelze, Dirk; Ilschner, Bernhard (Univ., Erlangen, Ger.). Z. Metallk., 60: 38-45(Jan. 1969). (In German).

The precipitation of the ϵ-phase in polycrystalline wires of a Fe 9.3 at.% Mo alloy was superimposed by deformation in torsion. The equipment constructed for this purpose is described. The deformation increases the rate of precipitation. The experimental results may be interpreted from correlation with light and electron microscopic micro-structural observations such that the increase in rate is due to an increased rate of nucleation. (auth)

12337 STUDY OF PRECIPITATION PROCESSES IN A Fe–Ni–Cr–Be ALLOY BY MEANS OF TRANSMISSION ELECTRON MICROSCOPY. Gruenberger, Wolfgang; Edelmann, Johannes (Institut fuer Metallische Spezialwerkstoffe, Dresden). Z. Metallk., 60: 57-61(Jan. 1969). (In German).

The precipitation starts with the accumulation of Be-atoms in {100} planes of the matrix, i.e., with the formation of coherent precipitates. This precipitated phase can again be soluted by formation of discontinuous precipitation. During aging at about 550°C a semicoherent intermediate bodycentered tetragonal phase is observed, which is formed platelike on {100} planes of the matrix. The influence of dislocations on the formation of this phase is discussed. (auth)

12338 INVESTIGATION OF PHASES IN THE LANTHANUM–GERMANIUM SYSTEMS. Lynchak, K. A.; Kuz'ma, Yu. B.; Kosolapova, T. Ya. Porosh. Met., Akad. Nauk Ukr. SSR, No. 12, 42-4(Dec. 1968). (In Russian).

The lanthanum – germanium system phases were investigated. The existence of four previously known compounds was confirmed. The width of the homogeneity domain of lanthanum digermanide is within the range of compositions $LaGe_{1.4}-LaGe_{2.0}$; for lanthanum monogermanide – $LaGe_{0.9}-LaGe_{1.0}$, and for the La_5Ge_3 phase — $LaGe_{0.5}-LaGe_{0.6}$. The phase La_4Ge_3 is formed at the composition $LaGe_{0.67}$. (auth)

12339 SUBSTRATE–OVERGROWTH INTERACTION DURING THE EPITAXIAL GROWTH OF NIOBIUM ON MAGNESIUM OXIDE. Olsen, K. H.; Hutchinson, T. E. (Minnesota Mining and Mfg. Co., St. Paul). pp 350-1 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

High purity Nb was vacuum vapor deposited by electron beam melting onto heated single crystals of MgO. The resultant film structures showed that chemical interaction between the substrate and condensate is the controlling parameter in structure formation. (J.R.D.)

12340 NEUTRON DIFFRACTION STUDIES IN SWIERK, 1958–1966. Leciejewicz, J. (Inst. of Nuclear Research, Warsaw). PTJ, 11: 453-66(1967). (In Polish).

A review of neutron-diffraction studies in the field of crystal chemistry of Pb and Te oxides and W – Fe carbides is presented. Magnetic structure determinations of several U compounds with P, Sb, and Bi are described. Magnetic structure studies involved also a number of intermetallic compounds of Fe and Mn and several ferrites with the spinel type of crystal structure. (NSA of Poland)

12341 BINARY SYSTEMS OF PLUTONIUM WITH PRASEODYMIUM, NEODYMIUM, AND SAMARIUM. Ellinger, F. H.; Land, C. C.; Johnson, K. A. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 29: 178-83(Feb. 1969).

The Pu – Pr, Pu – Nd, and Pu – Sm binary systems were investigated by thermal, micrographic, and x-ray diffraction methods. The solubility of each of these rare-earth metals in both δPu and ϵPu was found to be about 2 at. % maximum. No significant solubility in the α, β, γ or δ' allotrope was detected. The rare-earth bcc β phases will dissolve of the order of 30 at. % Pu, and they decompose by inverse peritectic reactions. The hexagonal α phases dissolve slightly less plutonium, the maximum being in the range 27 to 29 at. %. The stacking sequences of the close-packed layers of the αPr (4-fold) and αSm (9-fold) structures are modified by the solution of about 7 at. % Pu, whereas that of αNd is unaffected. (auth)

12342 KINETICS OF PRECIPITATION IN ALLOYS OF URANIUM–ALUMINUM AND URANIUM–IRON–ALUMINIUM. James, P. F.; Fern, F. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 29: 203-16(Feb. 1969).

The kinetics of precipitation of the intragranular particles in alloys of uranium – aluminum and uranium – iron – aluminum has been studied using transmission electron microscopy of thin foils. Measurements have been made of the size distribution, particle concentration and volume fraction in specimens heat treated (after gamma quenching) for various times (ranging from one minute to three months) at temperatures between 500 and 640°C. In the initial stages the growth of the particles is diffusion limited and the diffusion coefficient of aluminum in alpha uranium has been estimated as 1×10^{-14} cm^2/sec at 600°C in the ternary alloy, with an activation energy for diffusion of 2.6 ± 0.4 eV. The corresponding values in the binary alloy were 9×10^{-15} cm^2/sec and 4 ± 2 eV. After prolonged aging coarsening effects predominate but the observed particle size distributions and the growth kinetics are not consistent with the Wagner-Lifshitz theory, and the overriding process may be the ripening of precipitates by diffusion along dislocation networks and sub-boundaries. (auth)

12343 MORPHOLOGY OF PRECIPITATION IN ALLOYS OF URANIUM–ALUMINIUM AND URANIUM–IRON–ALUMINIUM. James, P. F.; Fern, F. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 29: 191-202(Feb. 1969).

Transmission electron microscopy of thin foils has been used to investigate the precipitates formed when alloys of uranium – aluminum and uranium – iron – aluminum are quenched from the gamma phase and annealed in the alpha phase. In the ternary alloy comparatively large precipitates of U_6Fe formed rapidly at grain boundaries. In both alloys the intragranular precipitates have been identified by selected area electron diffraction as UAl_2, except in the early stages of aging of the ternary alloy when most of the particles have been found to be of the ternary compound $U(Fe,Al)_2$. Evidence for orientation relationship between these phases and the matrix is presented and the atomic rearrangements involved in their formation are discussed. The thin foil observations indicate that the majority of the particles are preferentially nucleated on dislocations. (auth)

12344 BUBBLE GROWTH PROCESSES AT GRAIN BOUNDARIES IN CVD TUNGSTEN. Wolfenden, A.; Farrell, K. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 29: 133-43(Feb. 1969).

Some recent measurements of gas bubbles on the grain boundaries in chemically vapor deposited (CVD) tungsten after various annealing treatments are analyzed in terms of three existing models of bubble growth in solids. The bubbles had average diameters in the range 0.08 to 5.6 μm. For these bubbles, growth by bodily migration and coalescence is shown to be highly improbable for the annealing times involved. The general pattern of the experimentally observed bubble growth can be most closely described by a model involving bubble dissolution and reprecipitation. This growth is characterized by an activation energy of approximately 92 kcal/g-atom, which is close to that for self-diffusion of tungsten in the grain boundaries. At high annealing temperatures bubble growth is enhanced by overlapping or in situ coalescence. (auth)

12345 SHOCK-WAVE STUDIES IN CONDENSED MEDIA. Duff, R. E.; Gust, W. H.; Royce, E. B.; Mitchell, A. C.; Keeler, R. N.; Hoover, W. G. (Univ. of California, Livermore). pp 397-406 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

Shock and free velocity measurements were made on 6.4-mm and 3.2-mm thick samples of Ce, Dy, Eu, Gd, La, Nd, Pr, Sc, Sm, Y, and Yb by an optical flash-gap technique. Equations of state of Ar and Xe at high pressure were analyzed. The conductivities of shock-compressed liquid carbon tetrachloride between 70 and 160 kbar and liquid xenon at 150 kbar were measured. The pressure of the lowest transition of bismuth was determined using a quartz gage technique and the transition pressures for several alloys were obtained using an inclined mirror technique. The molecular-dynamic technique is explained for analyzing the structure of shock waves in dense fluids and solids. (F.S.)

12346 THORIUM–THORIUM DIOXIDE PHASE EQUILIBRIA. Benz, R. (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 29: 43-9(Jan. 1969).

Various Th–ThO_2 mixtures were investigated with thermal analysis, x-ray, and microscopic techniques. The following information on phase boundaries is deduced. The oxygen solubility in solid Th is less than the O/Th ratio of 0.003. The solid–solid transition of Th saturated with ThO_2 occurs at 1370 ± 30°C. A Th–ThO_2 eutectic occurs at 1735 ± 20°C with the O/Th ratio of 0.016 ± 0.005. A monotectic occurs at 2740 ± 100°C with the Th-rich and the O-rich liquid O/Th ratios of 0.40 and 1.5 ± 0.2, respectively. The Th-rich ThO_2 solidus varies from the O/Th ratio of 1.985 ± 0.01 at the eutectic to 1.87 ± 0.04 at the monotectic and to 1.997 ± 0.01 at the melting point. (auth)

12347 $\alpha/(\alpha + \beta)$ BOUNDARY IN THE Zr–Nb SYSTEM. Bethune, I. T.; Williams, C. D. (Chalk River Nuclear Labs., Chalk River, Ont.). J. Nucl. Mater., 29: 129-32(Jan. 1969).

Electron probe microanalysis was used to investigate the niobium content of the α and transformed β phases in the Zr–25% Nb alloy and to determine the location of the $\alpha/(\alpha + \beta)$ phase boundary. Stress-annealing treatments in the range 600 to 850°C were selected to give α and β grain sizes of 75 μm. Experimental values for Nb concentrations in the α- and β-phases have been plotted against homogenization temperature. A summary of analyses of niobium solubility in α-zirconium is tabulated. (J.C.W.)

12348 PHASE DIAGRAM OF THE MOLYBDENUM–HAFNIUM SYSTEM. Alfintseva, R. A.; Shishkin, E. A.; Shurin, A. K. pp 129-32 of Fazovye Prevrashcheniya. Kiev, Naukova Dumka, 1967. (In Russian).

Microstructural, differential-thermal, and x-ray analyses were used to study alloys of the Mo–Hf system and to construct the phase diagram. At 1880°C and with Hf 41 at. %, the eutectic crystallizes thus: liquid $\rightleftharpoons$ Mo_2Hf + β-Hf. At 1960 ± 20°C, the compound Mo_2Hf forms by a peritectic reaction between the melt and α–Mo. In the temp. range 1960–1800°C, this compound has a $MgZn_2$-type hexagonal cell, in the range 1800 to 900°C a $MgCu_2$-type cell, and below 900°C the $MgZn_2$-type. The maximum solubility of Hf in Mo is 35 at. % at 1960°C. At 1200°C, Mo dissolves Hf 9.5 at. %. (Referativnyi Zh.)

12349 SOME STRUCTURAL PROPERTIES OF THE METASTABLE β AND ω MODIFICATIONS IN PURE ZIRCONIUM. Bychkov, Yu. F.; Mal'tsev, V. A.; Martynov, E. D.; Markov, V. K. pp 58-67 of Met. i Metallovedenie Chist. Metallov. Moscow, Atomizdat, 1967. (In Russian).

The effect of a uniform 90 kbar-compression on 99.8% iodide-Zr was studied. X-ray analysis showed that, after compression, Zr specimens consisted of bcc β-phase and a phase with a more complex lattice that has the same interplanar distances as the ω-phase that is formed by quenching a Zr–10% Nb alloy from the β region. This ω-phase has an hexagonal lattice with c/d = 0.65 ± 0.01. After the high-pressure treatment, the specimens were cold-rolled from 0.35 down to 0.05 mm. With low degrees of deformation, the decreased microhardness is accompanied by transformation of the β and ω modifications into α–Zr. The β and ω modifications disappear after deformations of 60 and 40%, respectively. The effects of annealing temperature are as follows: at 100 to 150°C, there are no changes in microstructure or microhardness; 30 min at 200°C increases the ω-phase line intensity above that of the β-phase with a decrease in the line width; at 250°C, the ω-phase disappears although the β-phase remains and the α-phase becomes the main phase; and at 300°C, there is complete transformation into the α-phase. (Referativnyi Zh.)

12350 PHASE DIAGRAM OF THE NIOBIUM–TIN SYSTEM. Svechnikov, V. N.; Pan, V. M.; Beletsky, Yu. I. pp 152-7 of Metallovedenie Fiz.-Khim. i Metallofiz. Sverkhprovodnikov. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The phase diagram of the Nb–Sn system was constructed and shows three intermetallic compounds in the equilibrium condition, i.e., Nb_3Sn, Nb_6Sn_5, and $NbSn_2$. Nb_6Sn_5 is stable over a narrow temperature range from 815 to 920°C but $NbSn_2$ is stable from 860°C down to room temperature. It is suggested that there is stratification in the liquid state and also a monotectic equilibrium at 960°C: $liquid_1 \rightleftharpoons liquid_2 + \beta Nb_3Sn$. The monotectic point is at Sn 97 at. %. The homogeneous region of Nb_3Sn at this temperature lies between 14 and 32 at. % Sn. (Referativnyi Zh.)

12351 PHASE DIAGRAM OF THE NIOBIUM–TIN SYSTEM. Kuznetsova, V. G.; Kovaleva, V. A.; Beznosikova, A. V. pp 146-52 of Metallovedenie Fiz.-Khim. i Metallofiz. Sverkprovodnikov. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Microstructural, x-ray, x-ray micrographic, thermal, and chemical analyses were used to study the Nb–Sn phase diagram. The alloys were studied in the cast and quenched conditions and also after prolonged annealing up to 2000 hr. Three intermetallic compounds were found, i.e., Nb_3Sn (β-phase, ~75 at. %Nb), Nb_3Sn_2 (γ-phase, ~58 at. %Nb), and $NbSn_2$ (δ-phase, ~33.5 at. %Nb). Nb_3Sn_2 and $NbSn_2$ form by peritectic reactions at 910 ± 10°C and 840 ± 10°C, respectively. The compounds Nb_3Sn and $NbSn_2$ are stable down to room temperature but the stable region for Nb_3Sn_2 is restricted to between 820 and 910°C. The crystal structure of the δ-phase was studied with single crystals and was shown to have an orthorhombic structure with a = 5.65, b = 9.85, and c = 19.2 Å. The γ-phase structure has not yet been derived. The homogeneous regions of Nb_3Sn were determined: at 950°C, the solubility of Sn in Nb_3Sn is 0.6 at. % and Nb 1.3 at. %; at 1500°C these values increase to Sn 1.02 at. % and Nb 1.0 at. %. The solubility of Sn in solid Nb at 1000–1500°C is ≤2.5 at. % Sn. (Referativnyi Zh.)

12352 THE PHASE DIAGRAM OF THE Nb–Nb_5Si_3 SYSTEM AND THE CRYSTAL STRUCTURE OF THE COMPOUND Nb_3Si. Pan, V. M.; Pet'kov, V. V.; Kulik, O. G. pp 161-5 of Metallovedenie Fiz.-Khim. i Metallofiz. Sverkhprovodnikov. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The phase diagram of the Nb–Nb_5Si_3 system was constructed and showed that the compound Nb_3Si is formed by a peritectic reaction at 1880°C and is stable down to 1800°C. Prolonged annealing at temperature below this leads to breakdown by the reaction $Nb_3Si \rightleftharpoons \alpha + Nb_5Si_3$ (α being the solid solution of Si in Nb). The crystal structure of Nb_3Si was shown to be of the Ti_3P-type (space group $P4_2n$-C^{4}_{4}R) with a tetragonal lattice, a = 10.230, c = 5.189 Å, and c/a = 0.507. At 1880 ± 10°C, the eutectic α + Nb_3Si crystallizes, the eutectic point being at Si 18 at. %. The maximum solubility of Si in Nb is ~5 at. % at 1880°C. (Referativnyi Zh.)

12353 PHASE DIAGRAM OF THE TUNGSTEN–MOLYBDENUM–Mo_2Hf–W_2Hf SYSTEM. Alfintseva, R. A.; Svechnikov, V. N.; Shurin, A. K. pp 133-7 of Fazovye Prevrashcheniya. Kiev, Naukova Dumka, 1967. (In Russian).

Microstructural and x-ray analysis and measurements of hardness and microhardness were used to construct isothermal sections of the W–Mo–Mo_2Hf–W_2Hf system at 2150, 1800, and 1500°C. Ternary compounds $(W,Mo)_2Hf$ form in this system. A continuous series of solid solutions forms between W_2Hf and the isomorphous η–Mo_2Hf modification. At 2150 and 1800°C, the solubility of Hf in W is 7.5 and 5.5 at. %, respectively. With increasing Mo content, the solubility of Hf increases but the melting temperature of the alloys is lowered. (Referativnyi Zh.)

12354 THE PHASE DIAGRAM OF THE ZIRCONIUM–MOLYBDENUM SYSTEM. Svechnikov, V. N.; Spektor, A. Ts. pp 123-8 of Fazovye Prevrashcheniya. Kiev, Naukova Dumka, 1967. (In Russian).

Microstructural, dilatometric, differential-thermal, and x-ray analytical methods and microhardness measurements were used to study alloys of the Zr–Mo system and to construct the phase diagram. This system includes the compound $ZrMo_2$, ϵ, which is a Laves phase with a $MgCu_2$-type lattice formed by a peritectic reaction at 1900 ± 10°C and Mo 59%. This compound has no polymorphic transformations. The lattice constant of $ZrMo_2$ varies over the range Mo 65 to 70% at 1350°C, indicating the presence of a region of homogeneity although the boundaries of this region were not precisely determined. At 1540°C and with Mo 37%, the eutectic crystallizes thus: liquid $\rightleftharpoons \beta + \epsilon$. At 630°C and Mo ~9%, there is the eutectic transformation $\beta \rightleftharpoons \alpha + \epsilon$. The maximum solubility of Mo in β–Zr is 20% at 1540°C and the solubility of Zr in Mo is 10% at 1900°C. (Referativnyi Zh.)

12355 PHASE DIAGRAM OF THE NIOBIUM–GERMANIUM SYSTEM. Pan, V. M.; Latysheva, V. I.; Shishkin, E. A. pp 157-60 of Metallovedenie Fiz.-Khim. i Metallofiz. Sverkprovodnikov. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

Construction of the phase diagram of the Nb–Ge system showed three intermetallic compounds Nb_3Ge, Nb_5Ge_3, and $NbGe_2$. Of these, the first breaks down by a peritectic reaction on melting at 1970°C and the second and third melt congruently at 2110 and 1670°C, respectively. Three eutectic equilibria were found at the boundaries of this system, i.e., at 1940, 1590, and 950°C. The homogeneous regions of the various phases were determined. The limiting solubility of Ge in Nb at 1970°C is ~7 at. % but the solubility of Nb in Ge is extremely low. The thermal analysis data suggest that the compound Nb_5Ge_3 undergoes a polymorphic transformation at 1870°C. (Referativnyi Zh.)

12356 STRUCTURE CHANGES IN Fe–23 at. PERCENT Be ALLOY. Yagisawa, Kohei; Yoshida, Hidehiko (National Research Inst. for Metals, Tokyo). Jap. J. Appl. Phys., 8: 179-90 (Feb. 1969).

Structure changes in Fe-23 at.% Be alloy aged at temperatures between 300 and 800°C were studied by transmission electron microscopy. The structural changes with aging were classified depending on aging temperatures as follows: 1) 300 to 400°C; ordered structure, modulated structure, continuous precipitation of 1st metastable phase and discontinuous precipitation of 2nd metastable phase without grain boundary migration. 2) 500 to 800°C; continuous precipitation of 1st metastable phase in matrix, formation of discontinuously precipitated regions along boundaries, and continuous precipitation of stable phase in matrix. 3) Above 800°C; formation of dislocation networks, stable phase precipitation on them, and further formation of finer dislocation networks and precipitates. The structure of 1st metastable phase was fcc and expected to be Laves phase of $MgCu_2$ type. Variously shaped stable phase precipitates were Laves phase of $MgZn_2$ type. (auth)

12357 STRESS WAVE PROFILES IN SEVERAL METALS. Taylor, J. W. (Los Alamos Scientific Lab., N. Mex.). pp 573-89 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

Under a wide range of impact loading conditions the motions of dislocations appear to be the controlling factor in the structure of shock fronts. This places an upper limit on the strain rate which can be realized physically even for stress amplitudes of tens of kilobars. Time-resolved measurements are presented of the detailed behavior of shocks in several metals in the stress amplitude range roughly from ten to one hundred kilobars. It is shown that single-crystal beryllium has an anisotropic dynamic yield behavior from the known anisotropic mobility of dislocations in this material. Experiments in which 2024-T4 aluminum alloy specimens were subjected to dynamically induced tensile fracture also show that the subsequent damping of mechanical vibrations can be explained in terms of a simple linear relation between the average dislocation velocity and the maximum resolved shear stress. (auth)

12358 EFFECTS OF CRYSTAL ORIENTATION AND PURITY ON THE DYNAMICAL BEHAVIOR OF DISLOCATIONS. Stein, D. F. (General Electric Research and Development Center, Schenectady, N. Y.). pp 453-74 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

Experimental results on the effect of crystal orientation and purity on the yield stress, temperature dependence of the yield stress, and strain-rate sensitivity of several bcc metals are presented. The results are interpreted on the basis of their effect upon the parameters in the deformation equation based on dislocation dynamics. The approach is simply to relate the observed macroscopic behavior to the parameters in the deformation equation and to carefully examine what assumptions are necessary to relate dislocation dynamics to observed macroscopic yielding behavior. (auth)

12359 DISLOCATION VELOCITY AND DEFORMATION DYNAMICS IN MOLYBDENUM. Prekel, H. L.; Conrad, H. (Franklin Inst. Research Labs., Philadelphia). pp 431-52 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

Direct measurements of the velocity of dislocations in molybdenum are compared with results obtained from studies of micro ($10^{-6} < \epsilon < 10^{-3}$) and macro ($\epsilon > 10^{-3}$) deformation dynamics. Dislocation velocities were measured as a function of stress at room temperature. These were found to obey the equation $v = v_0(\tau/\tau_0)^m$ with m = 6.38. Comparing dislocation velocity measurements with Seeger's model for thermally activated nucleation of kinks it is shown that $H_K = fkTm = 4\tau^*v^* = 4.3 \times 10^{-2}\ \mu b^3$ where H_K is the kink energy, k is Boltzmann's constant, T is the temperature, τ^* is the thermal component of the stress and v^* is the activation volume. Moreover, in accordance with the theory, v^* is proportional to the reciprocal of τ^* for dislocation velocity measurements and for strain rate-change tests over the entire range from microstrain to macrostrain. Also, the value of H_K derived from the micro and macro deformation dynamics is in good agreement with that derived from the dislocation velocity measurements. Comparisons are also made between the value of the stress exponent m obtained from the dislocation velocity measurements with that obtained from strain rate-changes in the micro- and macrostrain regions. Taking the value of the athermal component τ_μ as the stress at the flat portion of the stress vs. temperature curves at high temperatures for macro deformation, or the value of $\tau^* = \tau - \tau_\mu$ as half the stress at which a loop first occurs in the micro deformation, the value of m derived from the relation m = $[\partial \ln\dot{\epsilon}/\partial \ln (\tau - \tau_\mu)]$ is equal to that derived from dislocation velocity measurements, where τ is the applied stress and τ_μ is the long-range internal stress. It is concluded that these results clearly establish that the deformation dynamics in both the micro- and macrostrain regions in molybdenum is directly related to the thermally activated motion of individual dislocations. A discussion of the significance of the various stresses observed during microstraining of metals in terms of long- and short-range obstacles to dislocation motion is also presented. (auth)

12360 THERMALLY ACTIVATED DISLOCATION MOTION AND ITS APPLICATION TO THE STUDY OF RADIATION DAMAGE. Smidt, F. A. Jr.; Bement, A. L. (Battelle-Northwest, Richland, Wash.). pp 409-29 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

Radiation damage in alpha iron was studied by an analysis of thermally activated flow to determine the basic dislocation-defect interactions. A method which circumvents the difficulties encountered in separating the athermal and thermal components of flow stress was used in the analysis and is briefly described. It consists basically of experimentally determining the stress dependence of the activation energy from an analysis of the temperature dependence of the flow stress. The experiments on irradiated iron show that the defects present cause only slight modifications in the mechanism of thermal activation, but produce large increases in the athermal stress component which are dependent on fluence and purity of the sample. It is concluded that the Orowan mechanism of hardening is most consistent with the experimental observations. (auth)

12361 LINEAR ARRAYS OF MOVING DISLOCATIONS EMITTED BY A SOURCE. Rosenfield, A. R.; Hahn, G. T. (Battelle Memorial Inst., Columbus, Ohio). pp 255-73 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

The positions of straight coplanar dislocations emitted by a single source were calculated as a function of time. This was accomplished by combining expressions for the stress sensitivity of dislocation velocity with expressions for the stress exerted on an individual dislocation by all the other dislocations emitted and with an approximate source-activation criterion. The resulting equations were evaluated on a computer for ten to twenty dislocations, and the computer solutions were generalized to large numbers of dislocations by applying the continuous approximation. The calculation results indicate that the dislocations behave cooperatively, arraying themselves in a manner resembling a pile-up against the source. The lead dislocation quickly attains a steady-state velocity and the actual stress on it is found to be up to twice as large as the applied stress, depending on the source-activation stress and whether the dislocations produced are screw or edge. As a result, the steady-state velocity of the lead dislocation can be several orders of magnitude greater than that of an isolated dislocation under the same applied stress. The results are shown to be consistent with previous data. In addition, the problems of evaluation of activation volume and of the ratio of edge to screw velocities are considered. In both cases the behavior of dislocations in arrays is shown to be markedly different from that of isolated dislocations. It is suggested that neglecting the interactions which occur in arrays can result in overestimates by a factor of two in activation volume and by one or two orders of magnitude in velocity ratio. (auth)

12362 INTERACTION OF DISLOCATIONS WITH HIGH-FREQUENCY SOUND WAVES. Alers, G. A.; Salama, K. (Ford Motor Co., Dearborn, Mich.). pp 211-29 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

When a high-frequency sound wave passes through a solid containing mobile dislocations, the velocity of the wave is reduced and the energy in the wave is dissipated. Measurements of these changes in velocity and attenuation give information on the drag experienced by moving dislocations, as well as on the effective length of dislocation lines between pinning points. Experimental results obtained by using these techniques on copper at temperatures below 4°K show that some mechanism exists by which dislocation motion becomes frozen out as the absolute zero of temperature is approached. If this mechanism involves thermal activation, the effective activation energies must be distributed over a very broad spectrum. Experiments measuring the response of the dislocation to a small static stress were also performed to find evidence for a predicted anharmonic response of firmly pinned dislocations. Even though these measurements were carried out at low temperatures to suppress unpinning effects, they showed sound velocity changes which indicated that unpinning was still taking place, thus overshadowing any anharmonic effects. (auth)

12363 NONLINEAR INTERNAL FRICTION, MODULUS CHANGES, AND STRAIN RELAXATION CAUSED BY PEIERLS-NABARRO POTENTIALS. Alefeld, G. (Kernforschung, Juelich, Ger.); Filloux, J.; Harper, H. pp 191-209 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

By use of the assumption that the periodicity of a crystalline lattice causes periodic variations of the energy of a hypothetically straight moving dislocation, a set of nonlinear internal friction, phenomena modulus defect phenomena and strain relaxation phenomena can be predicted. The nonlinear experiments are explained and typical results for aluminum and selected examples for tungsten are presented. (auth)

12364 INTERNAL FRICTION STUDIES OF DISLOCATION MOTION. Granato, A. V. (Univ. of Illinois, Urbana). pp 117-57 of Dislocation Dynamics. Rosenfield, Alan R. (ed.). New York, McGraw-Hill Book Co., 1968.

From Colloquium on Dislocation Dynamics Conference, Seattle, Wash. See CONF-670513.

Dislocation dynamics obtainable from internal friction measurements are given. The particular suitability of such measurements for the study of dislocation interactions with other defects, such as phonons, electrons, point defects, other dislocations, and the lattice itself is stressed. Studies of the dependence of dislocation velocities on stress in LiF, NaCl, and Cu, are given. (auth)

12365 DISLOCATION DYNAMICS. Battelle Institute Materials Science Colloquia, Seattle, Washington, U. S. A. and Harrison, British Columbia, Canada, May 1-6, 1967. Rosenfield, Alan R.; Hahn, George T.; Bement, Arden L. Jr.; Jaffee, Robert I. (eds.). McGraw-Hill Series in Materials Science and Engineering. New York, McGraw-Hill Book Company, 1968. 798p. $25.00. (CONF-670513).

A total of 31 papers are presented at the colloquium. A separate abstract was prepared for each of eight papers. Papers for which no abstracts were prepared are concerned with plastic response of solids, dislocation, strain relaxation, kinks, and slip. (J.C.W.)

For abstracts of individual papers see: 12357–12364.

12366 ELECTRON MICROSCOPIC IMAGE OF THORIUM OXIDE IN TUNGSTEN. Caspary, E. K. pp 193-202 of Technisch-Wissenschaftliche Abhandlungen der Osram-Gesellschaft. Band 9. Lompe, Arved (ed.). Berlin, Springer-Verlag, 1967. (In German).

Surfaces of tungsten rods with supplements of thorium oxide were represented electron microscopically. This was done with a two-stage printing technique (aluminum matrix, carbon print), which fulfills the requirements of segmented surfaces. Light microscopic structure pictures were compared with electron microscopic pictures. In these, thorium oxide inclusions with dimensions of approximately 0.05 μm could be detected. Two classes of size of thorium oxide inclusions could be distinguished from each other: very small inclusions with dimensions about 0.1 μm and larger dimensions of several μm. The small particles show the size of the thorium oxide crystals in the metal powder before sintering and the larger arise during sintering. (tr-auth)

Radiation Effects

Refer also to abstracts 12273, 12287, and 12360.

12367 (AERE-Trans-1086) ELECTRON MICROSCOPY OF SMALL DEFECT CLUSTERS IN IRRADIATED METALS. I. THE THEORY OF CONTRAST AND EXPERIMENTAL METHODS FOR DETERMINATION OF THE TYPE OF DEFECT. Ruehle, M. Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.), from Phys. Status Solidi, 19: 263-78(1967). 24p. Dep. CFSTI. UK 3s. 0d.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 11714.

12368 (AI-AEC-12763) HELIUM EMBRITTLEMENT OF A FERRITIC STAINLESS STEEL. Kramer, D.; Garr, K. R.; Pard, A. G. (Atomics International, Canoga Park, Calif.). Dec. 31, 1968. Contract AT(04-3)-701. 20p. Dep. CFSTI.

Helium was injected into small tensile samples of Type 405 stainless steel by alpha-particle irradiation from a cyclotron. Subsequent tensile testing at 550, 650, and 750°C revealed an increasing loss of ductility with temperature, which reached 55% at 750°C. The presence of helium caused the failure mode to change from trans- to intergranular failure. The grain-boundary cracks originated as small voids adjacent to grain-boundary carbide particles. Large helium bubbles, found attached to carbide particles, are responsible for the void formation, presumably through the action of grain-boundary sliding. (auth)

12369 (CEA-CONF-1050) CONTRIBUTION TO THE STUDIES CONCERNING THE HIGH-TEMPERATURE EMBRITTLEMENT OF AISI 316 AUSTENITIC STAINLESS STEELS AFTER IRRADIATION. Weisz, M.; Malkin, J.; Erler, J.; Andre, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 39p. (CONF-680604-10). Dep.

From Symposium on Radiation Effects to Reactor Metals, San Francisco, Calif.

The post-irradiated high temperature embrittlement of austenitic stainless steels and precipitation-hardened nickel alloys, which are potential cladding materials for fast reactor fuel elements, was investigated. These materials were irradiated to a dose of 3×10^{21} nvt ($E > 1$ MeV) in different thermal reactors and to a dose of 1.6×10^{22} nvt (total dose) in a fast reactor. The irradiation temperature was about 700°C in thermal reactors and about 500 to 600°C in a fast reactor. After irradiation, tensile tests and uniaxial stress rupture tests were performed at temperatures in the 600 to 800°C range. For all alloys, high temperature tests after irradiation showed a more or less pronounced embrittlement, not recoverable by any post-irradiation annealing. For a given alloy, at a given temperature, the lower is the rate of deformation, the more pronounced is the embrittlement. The 80-20 precipitation-hardened type nickel alloy is the most embrittled one. After irradiation, it fractures without any plastic deformation. The Hastelloy X alloy presents a lower reduction in ductility but it is more embrittled than the austenitic stainless steels of the AISI 316 type. For the 316 austenitic steels, the radiation induced hardening was low and disappeared at a maximum temperature of 800°C. Factors studied include those concerning the structural parameters such as grain size, precipitation, prestraining and chemical composition; and those concerning the conditions of irradiation. The embrittlement was less pronounced when the irradiation had been performed at room temperature and followed by an annealing at 650°C than when the temperature of irradiation was 650°C. The embrittlement became effective for doses as low as 10^{20} nvt ($E > 1$ MeV). In pile, creep tests gave rupture ductilities of about 2% under a flux of 5×10^{12} n/cm^2 ($E > 1$ MeV) for a rupture life of 500 to 1000 h at 700°C. Post-irradiation creep tests at 700°C showed a less pronounced embrittlement. (auth)

12370 (CEA-CONF-1106) ELECTRON IRRADIATED PURE NICKEL OBSERVED BY ELECTRON MICROSCOPY. Bourret, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1967]. 17p. (CONF-680910-7). Dep.

From International Conference on Vacancies and Interstitials in Metals, Juelich, Germany.

Irradiation of pure nickel foils was carried out between −40 and +10°C in vacuum (10^{-5} Torr) with 2- or 3-MeV electrons. Subsequently observed "black dots" are interstitial Frank dislocation loops. There is a well defined critical dose above which agglomerates are visible. The existence of a critical dose gives valuable information about the agglomeration process. These results prove that an interstitial defect is mobile below stage III. In the stage III temperature range there is a visible agglomeration of interstitials, which is interpreted either as a diffusion of loops by pipe diffusion or by diffusion of another interstitial-type defect. (auth)

12371 (COO-125-54) BASIC RADIATION DAMAGE STUDIES. Technical Progress Report, December 15, 1967–December 15, 1968. (Purdue Univ., Lafayette, Ind. Dept. of Physics). Dec. 30, 1968. Contract AT(11-1)-125. 5p. Dep. CFSTI.

The effect of different doping impurities on the annealing of lightly doped n-type germanium following electron irradiation at liquid helium temperature is investigated. Degenerate n-type germanium decreases in length when irradiated and is dependent on impurity concentration. (J.C.W.)

12372 (COO-1367-22) INTERACTION OF GLIDE DISLOCATIONS WITH INTERSTITIALS AND LATTICE VACANCIES. Meshii, M. (Northwestern Univ., Evanston, Ill. Technological Inst.). [1968]. 44p. (CONF-680715-1). Dep. CFSTI.

From Symposium on the Interactions Between Dislocations and Point Defects, Harwell, England.

The effects of electron irradiation and quenching on the yield stress and other mechanical properties of fcc metal single crystals were briefly reviewed and were correlated to the presence of interstitials and lattice vacancies, respectively. Quantitative expressions were obtained for the experimental data and were related to the interaction of a glide dislocation with an interstitial or a lattice vacancy. The agreement between the experimental observations and the theoretical predictions was found to be satisfactory. A complete understanding of the interactions cannot be achieved because of theoretical and experimental difficulties. (auth)

12373 (EURAEC-2057) A NEW DETERMINATION OF THE EMBRITTLEMENT IN STEEL USING SMALL SPECIMENS (≈0.2 cc) IN PARTICULAR WITH RESPECT TO IRRADIATION. Progress Report M68-581-50005, January 1–June 30, 1968. Koning, C.; van Elst, H. C. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, The Hague. Metaalinstituut). July 29, 1968. Contract 060-64-11-TEEN. 24p. (EUR-3995). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Tensile testing results of four pressure vessel steel (Soudotenax 56, HSB 55 C, 1.2. MD 07 and T1–U.S.S.), which received increasing fast neutron (>1 MeV) irradiation fluences between ca 10^{18} and 5×10^{20} n/cm^2 at an irradiation temperature of 80 degrees centigrade are reported. The increase in strength and the decrease in ductility were observed from load-deformation recordings. A comparison with available tensile test data from investigations of the RCN–Petten, the Netherlands, showed good agreement. The tendency towards saturation of the increase in the tensile strength properties occurred at a fast fluence of about 5×10^{19} n/cm^2. Several proposed relationships, expressing the increase in strength as a function of fast neutron fluence were investigated from the experimental data. (auth)

12374 (GA-8629) THE EFFECT OF SUBSTRUCTURE ON THE BIAXIAL STRENGTH AND IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Flynn, P. W.; Trozera, T. A. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 15, 1968. Contract AT(04-3)-167. 54p. (CONF-680604-13). Dep. CFSTI.

From Symposium on Radiation Effects to Reactor Metals, San Francisco, Calif.

A302-B steel was given thermal-mechanical treatments to improve mechanical properties through development of substructure. Cold work of 0.06 followed by a 435°C heat treatment produced a 28,000 psi (35 per cent) increase in lower yield strength without loss of uniform elongation. Specimens were irradited at <100 and 288°C to fast fluences in the range of 1×10^{18} to 5.2×10^{19} nvt. Standard tensile tests, biaxial stress (tube) tests, and instrumented Charpy impact tests were performed. Data from the biaxial tests were analyzed on the basis of uniform strain predicted from the uniaxial (simple tension) test. A mathematical analysis of the instability criteria is included. Data from the Charpy tests were analyzed to determine the relation between substructure and irradiation on the NDT shift, and on the way in which the sample breaking energy is distributed between crack initiation and propagation. It was found that the predicted instability strain in the biaxial test is not exceeded. A constant cell size (and degree of substructure) is reached at small amounts of cold work and does not appear to be exceeded. An appropriate substructure treatment may decrease radiation sensitivity and may increase energy absorption for fracture propagation in the Charpy test. (auth)

12375 (NRL-6803) THE EFFECT OF RESIDUAL ELEMENTS ON 550°F IRRADIATION RESPONSE OF SELECTED PRESSURE VESSEL STEELS AND WELDMENTS. Potapovs, Uldis; Hawthorne, J. Russell (Naval Research Lab., Washington, D. C.). Sept. 9, 1968. 32p. Dep. CFSTI.

The effect of variable residual element contents on 550°F radiation embrittlement sensitivity of pressure vessel steels has been examined in a continuing program. Results indicate that phosphorus and copper can contribute significantly to the 550°F radiation embrittlement sensitivity of Type A302-B steel. The results also show that vanadium may have a slight adverse effect and that sulfur is neutral, although it serves to decrease the full shear energy absorption level of the steel. Nitrogen variations from ≈0.008% to 0.015% in aluminum deoxidized steel have no significant effect, while the addition of aluminum to Ni-Cr-Mo steel with a given nitrogen content may slightly promote irradiation embrittlement. The program results demonstrate that apparent insensitivity to 550°F irradiation embrittlement can be consistently achieved with laboratory heats of a nominal A302-B steel composition by maintaining the total residual element contents at a low level. Radiation embrittlement sensitivity of weldments has been investigated in a program, aimed at the development of low sensitivity weld fillers for joining Ni-Cr-Mo steel. Data from this program again point to copper as a dominating factor in determining radiation embrittlement sensitivity. Two experimental weld wire compositions with low copper contents (<0.1%) are shown to possess resistance to 550°F irradiation embrittlement equal or superior to that of A543 base plate. (auth)

12376 (ORNL-TM-2328) DEVELOPMENT OF AUSTENITIC STAINLESS STEELS WITH IMPROVED RESISTANCE TO ELEVATED-TEMPERATURE IRRADIATION EMBRITTLEMENT. Bloom, E. E.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 49p. (CONF-680604-12). Dep. CFSTI.

From Symposium on Radiation Effects to Reactor Metals, San Francisco, Calif.

The effects of titanium in concentrations of 0.0 to 0.5 weight per cent on the tensile and creep-rupture properties of unirradiated and irradiated types 304 and 304L stainless steel have been investigated. It was found that within this range an alloy containing 0.15 to 0.25 weight per cent titanium has optimum postirradiation ductility. When this alloy is annealed 1 hr at 925°C prior to irradiation, the postirradiation ductility is essentially independent of tensile test temperature and increases as the strain rate is reduced in creep-rupture tests at 700°C. In contrast, the postirradiation ductility of standard types 304 or 304L stainless steel heat treated and irradiated under the same conditions decreases with increasing temperature or decreasing strain rate. These effects appear to result primarily from the effect of titanium on the intergranular fracture process, making crack initiation and/or propagation more difficult and thus reducing the susceptibility to the high-temperature irradiation embrittlement phenomena. (auth)

12377 OBSERVATION OF HELIUM BUBBLES IN AN IRRADIATED AND ANNEALED AUSTENITIC STEEL. Woodford, D. A.; Smith, J. P.; Moteff, J. (General Electric Co., Schenectady, N. Y. General Electric Co., Cincinnati). J. Iron Steel Inst. (London), 207: 70-6(Jan. 1969).

Post-irradiation transmission electron microscopy was performed on a split heat of a high-temperature iron-base, precipitation-hardened alloy (A-286) containing 0.001 wt % and 0.010 wt % natural boron. Irradiation was performed at reactor ambient temperature to a fluence of 4.8×10^{19} n/cm^2 ($E_n > 1$ MeV) and 6.5×10^{20} n/cm^2 (thermal). Following irradiation, individual specimens were heat treated at 760°, 845°, and 955°C and examined. These studies showed that all three heat treatments produced visible helium bubbles. Analysis of the bubble sizes and size distribution indicated that, for a given temperature, the higher boron content alloy yielded a larger mean bubble diameter. The mean diameter also increased with increasing annealing temperature for both boron contents. Measurements and subsequent calculations of the observed helium volume agreed well with predictions based on the ^{10}B atom concentration and thermal neutron fluence. Results of these studies also showed that virtually all the helium is associated with dislocations, and only a small fraction lies at grain boundaries or γ' precipitate particles. A contributing factor to the observed radioinduced embrittlement may be caused by bubbles pinning dislocations, especially in areas adjacent to grain boundaries. This would restrict dispersal of stress concentrations at grain boundary triple points. Another significant observation was the presence of shells of helium bubbles surrounding the precipitate particle TiN. The radii of the shells were approximately equal to the recoil distance of an α particle in an iron matrix. (auth) (UK)

12378 ELECTRON MICROSCOPY OF IRRADIATED AND MECHANICALLY TESTED TUNGSTEN. Rau, Robert C.; Ladd, Robert L.; Moteff, John (General Electric Co., Cincinnati). pp 314-15 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

The microscopic observations show the existence of a fluence threshold region at 5.9×10^{18} to 3.8×10^{19} nvt (E > 1 MeV) in which microstructure and mechanical properties undergo abrupt changes. (J.R.D.)

12379 EFFECT OF NEUTRON IRRADIATION ON THE BEHAVIOUR OF COPPER, COPPER + 2 AT. PERCENT ALUMINUM AND COPPER + 2 AT. PERCENT MAGNESIUM AT ELEVATED TEMPERATURES. El-Shanshoury, I. A.; Voronin, I. M.; Abdel-Azim, M. S. (Atomic Energy Establishment, Cairo). J. Nucl. Mater., 29: 161-8(Feb. 1969).

The effect of neutron irradiation ($1.7 \times 10^{17} - 8.15 \times 10^{19}$ n/cm^2, fast and $4.6 \times 10^{17} - 2.2 \times 10^{20}$ n/cm^2, thermal) on the mechanical properties and grain growth of pure copper, Cu + 2 at. % Al and Cu + 2 at. % Mg in the temperature range 25 to 900°C was studied. Irradiation produced changes in the mechanical properties with subsequent recovery at elevated temperatures. At temperatures higher than those of recovery appreciable differences in elongation to fracture of the irradiated and unirradiated alloys were observed. A linear relationship between the drop in ductilities and the thermal neutron integrated doses was found at 600°C. The differences in ductilities and in grain growth of the irradiated and unirradiated materials were explained by the presence of helium and/or lithium atoms generated through the $^{10}B(n,\alpha)^7Li$ reaction. (auth)

12380 INVESTIGATION OF RADIATION INDUCED HIGH-TEMPERATURE EMBRITTLEMENT OF FERRITIC STEELS IN THE TEMPERATURE RANGE OF THE $\alpha-\gamma$-TRANSFORMATION. Boehm, H.; Hauck, H. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 29: 184-90(Feb. 1969).

In connection with an investigation of the mechanism of high-temperature embrittlement the neutron irradiation induced embrittlement of three Cr-steels and one Mo-steel was studied in the range of the ferrite-austenite transformation-temperature, which was different due to the chemical compositions. The specimens were irradiated at 50°C up to a fluence of 5×10^{19} n/cm^2 (thermal). The results of the tensile test clearly indicate that a high-temperature embrittlement of the Cr-steels only occurs at temperatures above the $\alpha-\gamma$-transformation. The Mo-steel, which shows a tendency toward intergranular fracture in the unirradiated condition already embrittles below the $\alpha-\gamma$-transformation. No influence of the transformation on the embrittlement could be observed. (auth)

12381 DIFFUSION CREEP UNDER NEUTRON IRRADIATION. Hesketh, R. V. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 29: 217-22(Feb. 1969).

Integration of the diffusion equation shows that in a uniform stress or a non divergent stress gradient, the instantaneous neutron flux has no effect on steady diffusion controlled creep. This statement is general; it allows the mutual recombination of vacancies and interstitials, the creation of dislocation loops and other sinks by neutron irradiation, the presence of self stresses in the specimen and the dependence of the boundary conditions on neutron flux. A significant divergence is unlikely in practical cases, it requires a strength greater than is attainable in macroscopically strong solids. The existence of a Kirkendall effect is pointed out, together with the possibility of volume expansion. (auth)

12382 EFFECTS OF IRRADIATION DAMAGE ON THE PORTEVIN-LE CHATELIER EFFECT IN CARBURISED NICKEL-COPPER ALLOYS. Blakemore, J. S.; Hall, E. O. (Univ. of Newcastle, New South Wales). J. Nucl. Mater., 29: 238-40(Feb. 1969).

Carburized Cu-Ni alloys were irradiated and tensile tested within the initial range of testing temperature and strain rate for which serrated yielding (the Portevin-Le Chatelier effect) is normally observed. Wire samples prepared from high purity Ni shot and deoxidized Cu were carburized and neutron irradiated. Stress-strain curves were prepared. Irradiation damage removed the Portevin-Le Chatelier effect and the neutron irradiation increased hardening. Less hardening was observed in the carburized Cu-Ni alloy than in carburized Ni. (F.S.)

12383 FAST REACTOR INDUCED SWELLING IN AUSTENITIC STAINLESS STEEL. Holmes, J. J. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 29: 241-3(Feb. 1969).

The effect of fast reactor irradiation on the density of Type 304 L stainless steel was determined by irradiating annealed specimens at temperature ranges from 370 to 460°C. Densities were determined by an Archimedes technique of weighing first in air and then in carbon tetrachloride. Within this temperature range there does not appear to be any measurable temperature dependency. Volume increases of ~ 10% may be expected at EBR-II neutron fluences. (F.S.)

12384 VOIDS IN NEUTRON IRRADIATED FACE CENTERED CUBIC METALS. Brimhall, J. L.; Mastel, B. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 29: 123-5(Jan. 1969).

Void formation in aluminum, copper, and nickel is investigated at fluences as low as 3×10^{19} n/cm^2 (E > 1 MeV). Foil disks, 75 μm thick, were irradiated in either helium-filled or NaK-filled capsules. Results of the electron microscopic examination are tabulated; they indicate that the void formation in fcc metals during neutron irradiation may be a general phenomenon. (J.C.W.)

12385 EFFECT OF HELIUM GAS BUBBLES ON THE CREEP DUCTILITY OF AN AUSTENITIC ALLOY. Woodford, D. A.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater., 29: 103-10(Jan. 1969).

Post-irradiation transmission electron microscopy has been performed on a split heat of a high temperature precipitation-hardened alloy (A-286) containing 0.001 and 0.010 wt % natural boron. After annealing at 760, 845, and 955°C, foils were prepared from sections taken from close to the fracture of specimens creep-tested to failure. The observations were compared with those previously obtained for undeformed specimens. Helium gas bubbles were found to be arranged in spherical shells around coarse precipitates believed to be TiN. Any effect of creep deformation on bubble size was masked by the annealing treatment, and the bubble size did not differ systematically from that observed for the undeformed specimens. The measured increase in creep resistance with increasing helium atom concentration is explained in terms of a reduction of dislocation mobility. It is suggested that the reduced ductility and associated reduction in strain rate sensitivity after irradiation may be very sensitive to the gas bubble distribution. The observation of bubbles on dislocations lying in the boundaries may be particularly significant. (auth)

12386 VOZDEISTVIE YADERNYKH IZLUCHENII NA STRUKTURU I SVOISTVA METALLOV I SPLAVOV. (Effects of Nuclear Irradiation on the Properties of Metals and Alloys). Markovskii, E. A.; Krasnoshchekov, M. M.; Tikhonovich, V. I.; Chernyi, V. G. Kiev, Naukova Dumka, 1968. 168p.

Nuclear reactor radiation effects on the macro- and microstructure of high-melting metals and alloys were investigated. Processes of strengthening and weakening metallic alloys in stable or metastable state were analyzed. Effects produced by electron and γ quantum interaction with solids and reactions of heavy particles and fission fragments with metals are discussed. Radioinduced changes in mechanical properties of iron carbide alloys and radiation effects on the properties of annealed and heat resisting and non-ferrous metals and alloys are evaluated. Data are included on radiation of effects on the crystalline structure, porosity and antifriction properties of construction alloys. Effects of β-particles, γ quanta, fast neutrons, and mixed neutrons on hardening and softening of alloys and diffusion processes in alloys are discussed. 367 references. (R.V.J.)

Ceramics and Cermets

Refer also to abstracts 12260 and 12262.

12387 (NYO-1710-80) RESEARCH ON GRAPHITE. Summary Report, April 1, 1968-March 31, 1969. Walker, P. L. Jr.; Diethorn, W. S.; Kline, D. E. (Pennsylvania State Univ., University Park. Dept. of Materials Science. Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Dec. 20, 1968. Contract AT(30-1)-1710. 65p. Dep. CFSTI.

Research progress is reported under the following headings: carbon formation and graphitization, gas-graphite interaction and solid-state studies, dynamic mechanical properties of carbon and graphite, and fission gas diffusion in graphite. (M.C.G.)

Corrosion and Erosion

Refer also to abstracts 12267 and 12269.

12388 (AECL-2718) CORROSION TESTING OF URANIUM SILICIDE FUEL SPECIMENS. Bourns, W. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sept. 1968. 43p. Dep. CFSTI. CAN $1.50.

U_3Si is the most promising high density natural uranium fuel for water-cooled power reactors. Power reactors fueled with this material are expected to produce cheaper electricity than those fueled with uranium dioxide. Corrosion tests in 300°C water preceded extensive inreactor performance tests of fuel elements and bundles. Proper heat-treatment of U-3.9 wt % Si gives a U_3Si specimen which corrodes at less than 2 mg/cm^2 h in 300°C water. This is an order of magnitude lower than the maximum corrosion rate tolerable in a water-cooled reactor. U_3Si in a defected unbonded Zircaloy-2 sheath showed only a slow uniform sheath expansion in 300°C water. All tests were done under isothermal conditions in an out-reactor loop. (auth)

12389 EFFECTS OF NON UNIFORM BURN OFF ON THE KINETICS OF OXIDATION OF LARGE TUBULAR SPECIMENS OF GRAPHITE. Hawtin, P.; Huber, R. A. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 6: 887-99(Dec. 1968).

The course of an experimental oxidation of a tubular specimen of nuclear grade graphite, in which oxygen access was confined to the bore of the tube, was simulated using a previously derived mathematical model. The conditions chosen for the simulation were such that a marked burn off profile developed during the course of a run. The results obtained were used in an inverse calculation to derive overall estimates for the chemical reactivity, utilization efficiency, and the effective diffusion coefficient. These estimates were compared with the corresponding values for a uniformly burnt off piece of graphite. It was found that under the conditions examined (oxygen concentration at external graphite surface ≥5% of the bore value, overall burn off ≤9%) the effect of the non-uniformity on the burn off profile was negligible and that properties applicable to uniformly burnt off material could be used. (auth) (UK)

12390 AIR OXIDATION STUDIES IN A LONG GRAPHITE CHANNEL. Hawtin, P.; Gibson, J. A.; Huber, R. A. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 6: 901-15(Dec. 1968).

Experiments on the oxidation of short tubes of graphite in air were extended to long channels of graphite where the oxygen is depleted as it flows through the channel and the theory of reaction in porous solids which was developed for the earlier work was extended to cover this more general case. It was found that a useful approximation to the general theory can be obtained by considering the channel as a series of short sections and introducing the axial concentration effects via the problem boundary conditions. The theory was tested by experiments carried out in a vertical channel of graphite 14 ft long, 2 in. ID and 8 in. OD constructed from six blocks of British nuclear grade graphite. The inner graphite surface was exposed to oxygen–nitrogen mixtures which flowed through the bore of the tube. Evidence of the radial diffusional effect was obtained from gas concentration measurements at the outer surface. The oxygen was depleted by chemical reaction as it flowed through the channel bore giving rise to an oxygen concentration profile which was experimentally measured. No corresponding axial concentration gradient at the exterior surface was observed. The derived theory allowed the diffusional effects to be quantitatively estimated. Good agreement between the present results and previously reported values for similar graphites was obtained. (auth)(UK)

Preparation and Fabrication

Refer also to abstracts 11502, 11706, 12428, 12610, 13537, 13584, and 13586.

12391 (BM-RI-7225) JOINING REFRACTORY METAL COMPOUNDS BY HOT PRESSING. Kelley, John E.; Sumner, Donald H.; Kelly, Hal J. (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Feb. 1969. 26p.

A study was conducted to determine the feasibility of joining refractory metal compounds to each other and to oxide ceramics by a vacuum hot press-diffusion bonding method. Satisfactory joints were made of ZrC to ZrB_2, ZrN to ZrB_2, ZrC to ZrN, and of ZrC, ZrN, and ZrB_2 to Al_2O_3. Each of these joints contained a mixture layer comprising 50 weight-percent each of the two end compounds. The mixture layer, sandwiched between each end compound, enhanced bonding and smoothed out the thermal expansion gradient between the two end members. Strength and thermal shock tests showed that the joint areas of the ZrC, ZrN, and ZrB_2 were stronger and more shock resistant than the parent materials. Also included in the joining tests was one each of TiC to TiB_2, TiC to TiN, TiB_2 to TiN, and TiC to ZrB_2 joints. Each of these was well bonded, showing that the vacuum-hot-press method can be used for a variety of systems. (auth)

12392 (CEA-CONF-1044) CHANGE OF PYROCARBON INTO GRAPHITE. Maire, J. (Carbone-Lorraine, Gennevilliers (France). Division des Etudes Nucleaires); Rappeneau, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 30p. (In French). (CONF-680620–2). Dep.

From 18th Annual Meeting on Carbonization and Graphitization, Paris, France.

Evolution of pyrocarbon towards the single crystal was compared during heat treatments with and without compression. The influence of thermal annealing at temperatures above 3000°C on these samples was examined. The following characteristics were measured on the greater part of the samples: density, electrical resistivity ρ on the crystallographic directions a and c, thermal conductivity K and thermal expansion α on the same directions, magnetoresistance $\Delta\rho/\rho$, and Hall coefficient A on the direction a, crystalline orientation of carbon layers, and modulus of shearing. Treatment of pyrocarbons at 3000°C under load provides better results than heating to 3500°C without load. Annealing at 3500°C of pyrocarbons already heat-treated at 3000°C does not seem to improve appreciably the characteristics of the material. (auth)

12393 (NLCO-1035) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1, 1968–DECEMBER 31, 1968. (National Lead Co. of Ohio, Cincinnati). Jan. 1969. Contract AT(30-1)-1156. 29p. Dep. CFSTI.

The reaction path during thermal denitration of uranyl nitrate was plotted in terms of N-to-U and H-to-U atomic ratios. Techniques were developed for milling bulk UC to a powder suitable for plasma spraying. Two equations for describing metal flow in a crucible-tundish-multiple mold assembly. One equation was incorporated in a computer program to give the amount of metal in any of the three components during a pour. The solubility rate of UC in molten uranium was studied. The reaction can be characterized by uranium infiltration of the carbide particle boundaries and disintegration of the solid carbide. (M.C.G.)

12394 (ORNL-tr-1782) PREPARATION OF PARTICLES OF URANIUM CARBIDE BY THE SOL-GEL METHOD. Cogliati, G.; Lanz, R.; Lupparelli, V.; Maltzeff, P.; Mezi, E.; Recrosio, A. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report DI.CHI(66)1. 29p. Dep. CFSTI.

The possibility of obtaining uranium carbide particles by the sol-gel method is considered. Preliminary tests for determination of its density in mercury, the C/U ratio, and of the x-ray structure were made. The carburization of the uranium dioxide was not particularly difficult either when the carbon was incorporated into the particles or when it was external to the particles. Carburization of the particles of uranium dioxide mixed with powdered carbon eliminates the necessity of incorporating the carbon in a collidal solution of uranium(IV), avoidance of inconvenience due to the presence of carbon during dispersion of the colloidal solution and gelation of the particles, and simplifies design of a plant that could produce particles of either uranium dioxide or carbide. The principal difficulty in carburization with powdered carbon on the outside of the particles of uranium dioxide lies in the separation of the carbide particles from the excess carbon powder. This separation is generally made by settling in anhydrous carbon tetrachloride. It was concluded that this difficulty could be overcome by carrying out the carburization in a current of inert gas containing a hydrocarbon or by coating the particles of uranium dioxide with a layer of an organic compound, which decomposes at high temperatures (for example, divinylbenzene). It could be carried out in such a way that all carbide particles would be covered with a light layer of carbon that would protect them from atmospheric humidity; the product obtained could thus be handled in air. It was noted that the uranium carbide particles prepared by a sol-gel process show a stability to the air much greater than that reported in the literature. This may be due to the lack of porosity of the particles. (auth)

12395 (SC-TM-68-287) COMPOSITE FILM METALLIZING FOR CERAMICS. Hollar, E. L.; Rebarchik, F. N.; Mattox, D. M. (Sandia Labs., Albuquerque, N. Mex.). May 1968. 10p. Dep. CFSTI.

A technique for forming a solderable/brazeable coating on the surface of ceramics by a low-temperature deposition process is described. The technique uses a controlled atmosphere containing a partial pressure of oxygen to allow the formation of an interfacial transition oxide region. This type of interfacial region increases the adhesion between the resulting coating and the ceramic surface. The system has been used to apply a niobium/silver metallizing layer to fused silica which can subsequently be brazed using a high-temperature braze alloy. (auth)

12396 (WARD-3791-27) URANIUM–PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1968. Biancheria, A.; Jacoby, W. R. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Oct. 1968. Contract AT(30-1)-3791. 54p. Dep. CFSTI.

Development of acceptable processes for fabricating stoichiometric fuel was continued. Preparation of experimental hyperstoichiometric pellet batches was initiated. Studies indicated that: initial carbon contents of 4.45 and 4.70 wt % are required to yield stoichiometric and hyperstoichiometric pellets, respectively; milling times should be increased from 2.5 to 6.0 hr to achieve better density control; and maximum pressing pressures of 20 tsi are sufficient to yield desired densities while minimizing pellet defects. Detailed evaluation of several batches of fuels showed higher carbon contents than specified. Two pins containing $Cr_{23}C_6$-modified fuel were loaded, encapsulated, and inspected. The nine fuel pins in GETR continued to operate satisfactorily. (M.C.G.)

12397 PROCESS FOR THE PREPARATION OF URANIUM DIOXIDE–ZIRCONIUM DIOXIDE AQUASOLS. (to W. R. Grace and Co.). British Patent 1,138,233. Dec. 27, 1968. Priority date May 19, 1965, United States.

A process for the preparation of a UO_2-ZrO_2 aquasol comprises heating at 80 to 120°C until peptization occurs in a mixture, having a pH of 0.5 to 4, of an alkaline-precipitated electrolyte-free hydrous oxide, which is either ZrO_2, UO_2, or a mixture of the two, and an aqueous solution of one or both of a U^{4+} salt and a ZrO^{2+} salt. If it is necessary for pH adjustment, an acid is added. The amounts of the salts of monobasic acids present are such that the aquasol contains the desired proportions of UO_2 and ZrO_2. (B.L.M.)

12398 PROCESS FOR MAKING DISPERSIONS OF PARTICULATE OXIDES IN METALS. Lambert, John B. (to Fansteel Metallurgical Corp.). U. S. Patent 3,415,640. Dec. 10, 1968. Filed Oct. 28, 1966.

When uniform dispersions of small-particle-sized refractory metal oxide particles, such as thoria, in certain matrix metals, such as nickel and nickel-chromium alloys, are made by first making a mixture of the refractory oxide particles and oxides of the matrix metals and then reducing the matrix metal oxide to metal at elevated temperature, there is a marked tendency for the refractory oxide particles to grow to a size larger than desired. This growth tendency is limited by spray-drying droplets of an aqueous solution of a compound of the matrix metal, in which there is dispersed a compound of the metal of the refractory oxide, under the following conditions: (1) The spray droplets are atomized to a number average diameter in microns, X, less than 100 into an atmosphere at a temperature of $(0.075X^2 + 200)$°C. to 950°C, and thereafter. (2) The matrix metal compounds in the dried droplets are reduced in a reducing atmosphere, the temperature of which does not exceed 950°C until the reduction is at least 50% complete. (Offic. Gaz.)

12399 IMPROVED COKING IMPREGNANT FOR CARBON. Greider, Clarence Edwin (to Union Carbide Corp.). British Patent 1,138,307. Jan. 1, 1969. Filed May 9, 1966.

A carbonizable impregnant for lowering the permeability of carbon articles is described; this is in the form of liquid solution at room temperature (21°C) and consists essentially of furfural, between about 10 and 70 per cent by weight of the solution of coal tar pitch having a melting point below 110°C, coal tar having a specific gravity not less than 1.1 or a mixture thereof, the coal tar pitch, coal tar or mixture thereof containing not more than 5 per cent by weight of materials insoluble in furfural. An acid catalyst provides thermosetting of the liquid upon heating to elevated temperatures. For the catalyst moderately strong acids can be used, such as benzene sulfonic acid, toluene sulfonic acid, and dilute sulfuric and hydrochloric acids; the presence of free acid, however, greatly shortens the life of the impregnant and so latent acids are preferred (e.g., diethyl sulfate, benzene sulfonyl chloride, toluene sulfonyl chloride or methyl toluene sulfonate). The mixture of coal tar or coal tar pitch dissolved in furfural, with the addition of a suitable catalyst, is said to have the properties of a thermosetting resin and when used as an impregnant for carbon articles to give superior reduction in permeability. (UK)

12400 FUEL ELEMENT FABRICATION. Lloyd, Henry (to United Kingdom Atomic Energy Authority). U. S. Patent 3,415,911. Dec. 10, 1968. Priority date Nov. 16, 1964, Great Britain.

A method of fabricating nuclear fuel elements is described which consists of loading bodies of ceramic nuclear fuel into a sheath and subsequently fracturing or cracking the bodies within the sheath. Preferably the fuel bodies are cylindrical and dimensioned to easily enter the sheath, the bodies are fractured or cracked by mechanical means, such as ultrasonic vibration or thermal shock. (Offic. Gaz.)

12401 SINTERED URANIUM DIOXIDE. Elyard, Charles Anthony; Potter, Terence Jefferson (to United Kingdom Atomic Energy Authority). British Patent 1,137,551. Dec. 27, 1968. Filed Apr. 23, 1965.

At temperatures of 1600°C or lower the release of gaseous fission products from irradiated UO_2 ceramic fuel elements is believed to take place by diffusion through the solid ceramic, and the rate of release can be reduced by making the ceramic as dense as possible. At higher temperatures, however, and particularly where a steep thermal gradient exists, major structural change can occur in the UO_2, particularly by the formation of columnar grains in place of the normal equi-axed grain, and this causes a more rapid release of fission gases, with the consequent risk of the container bursting. A UO_2 ceramic which does not undergo columnar grain growth at temperatures above 1600°C contains 0.1 to 4 wt % iridium (preferred concentration range 0.2 to 2 wt %). The UO_2 ceramics can be prepared by mixing a solution of an iridium compound with UO_2 powder to form a slurry, drying the slurry to powder form, heating the powder to at least 400°C to decompose the iridium compound, the subsequently fabricating the ceramic from the powder. The iridium compound may be ammonium chloro-iridite, $(NH_4)_3IrCl_6 \cdot H_2O$. (UK)

12402 COLD CATHODES FOR GAS-DISCHARGE HIGH-VOLTAGE DEVICES MADE OF CERMETS ON THE BASE OF ZIRCONIUM DIOXIDE. Vishnevskii, A. I.; Zilberberg, V. G.; Karpinos, D. M.; Novikov, A. A.; Ozeran, A. E. (Kiev Polytechnic Inst. Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 33-8(Nov. 1968). (In Russian).

A technology of producing cermet samples on the base of zirconium dioxide with tungsten, molybdenum, and iron additives by the method of hot pressing is described. The results of testing samples of the materials in high-voltage glow discharges are presented. The coefficients of ion-electron emission and cathode sputtering are determined. (auth)

12403 STUDIES ON THE SYSTEM URANIUM DIOXIDE–COPPER. Ondracek, G.; Kanellakopulos, B. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 29: 169-77(Feb. 1969). (In German).

The construction of a UO_2-Cu phase diagram was attempted. It may be possible, that UO_2-Cu-cermets could be used as a fuel for high flux reactors with fast neutrons, since some Cu-alloys for cladding are compatible with sodium coolants. Dense pellets can be obtained by cold pressing and sintering (density > 90% TD), with stable shapes at all concentrations. It is shown by measurements of the contact angle that there is poor wettability between copper and uranium dioxide. Heat treatment above the melting points of one or both components results in segregation. No tendency to form a new phase at the boundary is observed. UO_2-Cu cermets are a stable combination. The phase diagram is a limiting case of monotectic, similar to that of UO_2-Mo. (auth)

12404 PREPARATION OF URANIUM CARBIDE FROM URANIUM TETRAFLUORIDE. Mitamura, Takashi (Univ. of Saitama, Japan); Kanno, Masayoshi; Mukaibo, Takashi. J. Nucl. Sci. Technol. (Tokyo), 6: 6-11(Jan. 1969).

The reaction of UF_4 with Al and graphite to form UC was studied in the temperature range between 900 and 1200°C. From a mixed powder of stoichiometric composition, UC with a small amount of UF_3 was obtained, corresponding to the reaction $3UF_4 + 4Al + 3C \rightarrow 3UC + 4AlF_3$, under constant flow of Ar. The x-ray pattern of the product from a 300-min reaction at 1200°C revealed the presence solely of UC phase. Taking the effect of Al content into consideration, the reaction is better explained by the reaction formula: $UF_4 + 2Al + C \rightarrow UC + AlF + AlF_3$. The by-products were ascertained by chemical and x-ray analyses. The reaction follows a logarithmic law derived from the weight change vs. holding time curves. Products of single phase of UC were obtained within a relatively short time above 1000°C. The apparent activation energy of the reaction was determined to be 64 kcal/mol. (auth)

12405 PREPARATION OF COATED $(Th,U)C_2$-PARTICLES BY REACTION, SINTERING, AND COATING IN A FLUIDIZED BED. Goergenyi, T.; Huschka, H.; Popp, W. (NUKEM, Wolfgang, Ger.). J. Nucl. Mater., 29: 126-8(Jan. 1969).

A process is described for preparation of coated $(Th,U)C_2$-fuel particles by converting oxides to carbides, including sintering, and coating in one run in the same fluidized bed. Green kernels are inserted into the fluidized bed. While they are fluidized they are heated and converted into carbide. A thin layer of pyrolytic carbon is then deposited on the particles to prevent them from sticking together during the subsequent heating. Coating is then done in the usual way. (J.C.W.)

12406 HOT PRESSING OF ZIRCONIUM DIBORIDE. Chown, J. (Doulton Research Ltd., Chertsey, Eng.). Sci. Ceram., 4: 53-67(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

The final stage of densification of ZrB_2 during hot pressing follows accurately a logarithmic relationship between the fractional porosity and time at constant temperature, and fits the rate equation proposed by Murray et al. (Trans. Brit. Ceram. Soc. 53: 476, 1954) to describe densification according to a mechanism based on plastic or viscous flow. Doubt is, however, cast on the concept of such a mechanism as it implies that the high-temperature mechanical properties are inferior to those observed with this and related materials. The results were therefore compared with the work of Rossi and Fulrath (J. Amer. Ceram. Soc. 48: 558 (1965)) on Al_2O_3, who derived an alternative, but similar, densification equation based on a mechanism of diffusion. It was found that this leads to an activation energy of 140 kcal. $mole^{-1}$, corresponding to sintering of ZrB_2 via vacancy diffusion. It is believed that the initial rapid densification which began at ca 1400°C was caused by particle fragmentation and rearrangement, but this was later overtaken by the main final sintering mechanism. (auth) (UK)

12407 STABILIZED ZIRCONIA PARTICLES BY SOL-GEL PROCESSES. Woodhead, J. L. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. Ceram., 4: 105-11(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

The general principles of a sol–gel process for the preparation of particles are: the conversion of a metal salt or oxide to a concentrated sol; dehydration and/or de-ionization of the sol to a gel; and calcination and sintering of the gel to oxide. The versatility of this process has been exploited chiefly for the production of experimental quantities of ThO_2, UO_2, PuO_2, ThC_2, and UC_2, either alone or as mixtures. This sol–gel process has now been examined for the preparation of particles for non-nuclear ceramics, and a typical example of the preparation of particles of zirconia is described. Zirconia sols were prepared and converted to microspheres (20 to 100 μm) by gelation in an organic phase. The compatibility of zirconia sols with calcium and yttrium salts (calcia and yttria as stabilizers) was established over a range of concentrations and such sols were converted to gels by evaporation. When calcined, the products densified rapidly, and stabilized zirconia of 95% theoretical density was prepared at 1150°C. (auth) (UK)

12408 INFLUENCE OF ATMOSPHERE ON THE SINTERING OF HIGH-SURFACE-AREA URANIUM DIOXIDE. Kolar, D.; Brcic, B. S.; Zatler, B.; Marinkovic, V. (Nuclear Inst. J. Stefan, Ljubljana, Yugoslavia). Sci. Ceram., 4: 189-200(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

Experiments showed that the influence of reducing and of oxidizing atmospheres on the sintering of uranium dioxide powders with different specific surface areas depends on the activity of the powder. The combination of excess oxygen in non-stoichiometric UO_2 and high surface area of the initial powder may limit the sintered density and lead to the formation of intergranular porosity. In such cases higher densities may be achieved by sintering at lower temperatures or by sintering in hydrogen. (auth) (UK)

Properties Evaluations

Refer also to abstracts 12294, 12393, 12610, 13503, and 13504.

12409 (CEA-R-3436) URANIUM SELF-DIFFUSION IN URANIUM MONOCARBIDE. Villaine, Philippe (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sept. 1968. 64p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, France.

Uranium selfdiffusion in near-stoichiometric stabilized uranium monocarbide was investigated in the temperature range from 1450 to 2000°C. A thin layer of ^{235}UC was deposited on the samples and the diffusion profiles were analyzed by both sectioning and alpha-spectrometry techniques. The variation with temperature of the selfdiffusion coefficient can be expressed by the equation: $D = 7.5 \times 10^{-5} \exp[-(81 \pm 10)\ \text{kcal/mole}/RT]\ \text{cm}^2\text{s}^{-1}$. The coefficient D decreases with increasing carbon content. Autoradiographs and profile analysis evidenced a preferential grain-boundary diffusion at all temperatures and compositions investigated. This phenomenon was used for a study of grain-boundary migration and for the evaluation of grain-boundary diffusion coefficients. The activation energy thus derived is close to the volume diffusion activation energy. (auth)

12410 (GA-9099) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending November 14, 1968. Bokros, J. C.; Engle, G. B.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 22, 1968. Contract AT(04-3)-167. 41p. Dep. CFSTI.

Densitometric separation was made on near-isotropic graphite. Petroleum-coke bodies containing Al and Al-Ti alloys are being investigated to determine their worth as catalytic agents in the graphitization of cokes. Dimensional changes, thermal expansivity changes, microstructural changes, and porosity changes are being measured on CHN and H-315-A graphites. Property measurements (except hardness) were completed on a series of irradiated pyrolytic carbon samples annealed for 1-hour periods at 100°C intervals between 400 and 3000°C. Measurements were made of the changes in layer spacing and apparent crystallite height of a series of pyrolytic carbons irradiated at 950 and 1160°C. The thermal conductivities of irradiated and unirradiated carbons were measured. (J.C.W.)

12411 (GEAP-5672) A THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 4. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Oct. 1968. Contract AT(04-3)-189. 10p. Dep. CFSTI.

Thermodynamic information about segregation of urania-plutonia solid solutions used in fast reactor environments is presented. Investigation of plutonia segregation from the standpoint of phase separation (liquid-solid transformation) is essentially complete. Results are presented, which cover the hypostoichiometric range of compositions of the urania-plutonia solid solution. This region is characterized by a slight maximum in the liquidus-solidus curves at an oxygen-to-plutonium ratio of about 1.75. The maximum is more apparent at higher concentrations of plutonia. (auth)

12412 (LA-4057) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Summary Progress Report No. 7, August 1–October 1, 1968. Smith, Morton G. (Los Alamos Scientific Lab., N. Mex.). Dec. 31, 1968. Contract W-7405-eng-36. 35p. Dep. CFSTI.

The raw materials acquired are described and the manufacturing procedures used to produce the experimental graphite are summarized. Physical and mechanical properties in relation to temperature dependency are given. The variables of the extrusion process affect the properties of graphites. The variables include die-system design, speed, pressure, vacuum, and temperature. The behavior of furfuryl alcohol-formaldehyde copolymer resins as binders in extruded graphites is investigated. Crystalline parameters of carbon blacks in six as-received samples are listed. Graphitization resulted from heat treatment. The effects of boron content and silicon-doping on electric resistivity and thermal conductivity of graphites at 300°K are summarized. (J.C.W.)

12413 (ORO-3508-4) EFFECT OF RADIATION AND GAS CONCENTRATION ON RARE GAS DIFFUSION IN SOLIDS. Annual Progress Report, November 1, 1967–October 31, 1968. Elleman, Thomas S. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). Nov. 1, 1967. Contract AT(40-1)-2508. 68p. Dep. CFSTI.

Diffusion of ^{133}Xe in CsI was studied as an aid to understanding rare gas diffusion in more complex systems, such as nuclear reactor fuels. Diffusion at low gas concentrations and negligible radiation damage levels was measured by growing single crystals of CsI containing ^{133}I which decayed to ^{133}Xe ($T_{1/2}$ = 20.8 hr). Both the time rate of release and temperature dependence of the rare gas diffusion coefficient were consistent with classical diffusion solutions. Crystals containing high concentrations of defects exhibited rare gas trapping and anomalous diffusion kinetics. Trapped gas tended to stabilize defects and prevent annealing during heating. Diffusion of fission gas recoiled into CsI specimen surface layers from an external fissionable source obeyed classical diffusion solutions at low fission recoil concentrations, while at high concentrations, radiation damage created traps which decreased gas diffusion rates. These traps differed significantly from natural defects in trap concentration, gas atom binding energies, and annealing characteristics. Increasing the gas concentration independent of radiation damage also lowered rare gas diffusion coefficients, showing that formation of small gas atom clusters also produced trapping. Results showed that classical rare gas diffusion could be obtained under ideal conditions and that distinctive trapping behavior with different characteristics could be associated with the presence of natural defects, radiation damage, and high gas concentration. Rare gas diffusion measurements on uranium doped crystals gave anomalous diffusion behavior which was traced to inhomogeneities in the uranium distributions in the crystals. Diffusion of fission recoil ^{133}Xe from CsI and CaF_2 crystals cut at different crystal orientations appeared to exhibit an orientation effect but the mechanism remains unclear. (auth)

12414 (RD/B/N-1186) ENDURANCE OF BONDED SOLID LUBRICANT FILMS. Houghton, J. E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 23p. Dep.

The frictional behavior of thin films of graphite, MoS_2, WS_2, and metal-free phthalocyanine, each bonded using sodium silicate, was investigated over the temperature range from 20 to 800°C in a dry carbon dioxide atmosphere. The reliability of such films was found to be superior to that of unbonded films; this is attributed to more effective utilization of film surface area resulting from greater film thickness. Temperature limitations imposed by lubricant oxidation were found to be less stringent than previously thought, the binder apparently inhibiting oxidation. The first three of the bonded films are suitable for use in many reactor mechanisms. (auth) (UK)

12415 USE OF SECONDARY IONIC EMISSION IN THE STUDY OF SELF-DIFFUSION OF O IN UO_2. Contamin, Pierre; Slodzian, Georges (CEN, Grenoble, France. Faculte des Sciences, Orsay, France). Compt. Rend., Ser. C, 267: 805-8(Sept. 30, 1968). (In French).

Use of an ionic analyzer made possible the determination of autodiffusion profiles of ^{18}O in partially fused bulk UO_2. The variations in the relative intensities of the secondary ions $^{18}O^-$ and $^{16}O^-$ emitted by the sample bombarded by 13.8-keV argon ions were measured. The speed of pulverization of the oxide, which depends on the orientation of the grains with respect to the primary beam, is approximately 0.3μ/min. (tr-auth)

12416 INVESTIGATION OF THE STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS OF OXYGEN IN TITANIUM AND ZIRCONIUM. Model, M. S.; Shubina, G. Yu. Izv. Akad. Nauk SSSR, Metal., No. 6, 143-57(Nov.-Dec. 1968). (In Russian).

X-ray and microstructural investigations were made of Ti−O and Zr−O systems and their physical properties were determined in relation to composition and temperature. The data obtained were compared with published data and the phase diagrams confirmed. Formation of superstructures in solid solutions of Ti−O and Zr−O is the typical case of ordering and it takes place without essential change of the interatomic distances and without changes in the nature of the chemical bond. The nature of the chemical bond in ordered solid solutions of the Ti−O system is close to the nature of chemical bonds in the Zr−O system. Measurement of the thermoemf of the Ti−O system after annealing showed that the system cannot be used as a thermocouple material. (tr-auth)

12417 THE RELATION OF STRENGTH AND HARDNESS OF THE ALLOYS WC–TaC–Co AND WC–NbC–Co AS A FUNCTION OF TEMPERATURE. Panov, V. S.; Meerson, G. A. Izv. Akad. Nauk SSSR, Metal, No. 5, 160-4(Sept.-Oct. 1968). (In Russian).

The maximum strength and hardness of WC−TaC−Co and WC−NbC−Co was tested as a function of temperature from 20 to 800°C. Bend tests on the strength were affected by the temperature and also with the content of NbC. The hardness of WC−TaC−Co and WC−NbC−Co was also affected by the temperature. Hardness curves as a function of temperature were found to depend on the content of TaC or NbC in WC−Co alloys. (P.C.H.)

12418 THE STRUCTURE AND THE PHYSICAL-MECHANICAL PROPERTIES OF CAST AND SINTERED ALLOYS Co–WC. Tumanov, V. I.; Shchetilina, E. A.; Fimanova, S. M.; Serebrova, O. I. Izv. Akad. Nauk SSSR, Metal, No. 5, 152-9(Sept.-Oct. 1968). (In Russian).

The coersive force of Co−WC is practically identical in all specimens obtained by casting or sintering methods. The specific electric conductivity, microhardness, and inelastic modulus depend on the content of WC specimens. In regions of small WC content (0.1 to 0.25 mole %) the extreme of elastic modulus for cast or sintered specimens was due to a certain order in the atom distribution in the solid solution. Increased content of WC in solid solutions of Co affected the plastic properties of the specimens. The level of the strength and formation properties of cast specimens was considerably lower than the level of properties during tensile stress of sintered specimens of Co−Wc and comprised 30 to 90%. During the second phase in Co−WC alloys (structurally free WC) a lowering of plasticity was observed more so for the specimens obtained than with those ordinarily used in powder metallurgy. (P.C.H.)

12419 DYNAMIC MECHANICAL BEHAVIOR OF STRESS-GRAPHITIZED AND BORON-DOPED PYROLYTIC CARBON. Taylor, R. E.; Kline, D. E. (Pennsylvania State Univ., University Park). Carbon, 6: 749-64(Dec. 1968).

The effects of stress-graphitizing and of co-deposition of boron on the dynamic mechanical properties of pyrolytic carbon were investigated from 4 to 700°K. Stress-graphitizing was found to increase both the internal friction and the dynamic modulus in the strain-amplitude-independent region. The increase in modulus was consistent with an increase in the orientation density function. The order-of-magnitude increase in the internal friction may be explained by damping involving basal-plane dislocations associated with the increase in three-dimensional ordering. An internal friction peak, similar to the α peak previously reported in commercial graphites and pitch-bonded natural graphite crystals, was observed in the vicinity of room temperature for some of the stress-graphitized samples. It was found that low-dose reactor irradiation further increased the modulus, but that it caused the overall level of the internal friction to decrease. The internal friction of pyrolytic carbon and co-deposited boron (not stress-graphitized) somewhat resembled that of non-boronated, as-deposited pyrolytic carbon. Values for the dynamic modulus of some of the boronated samples, however, were significantly greater than those obtained on the non-boronated, as-deposited material, which may suggest that the co-deposited boron resulted in some improvement in the crystalline structure. (auth) (UK)

12420 INFLUENCE OF LANTHANUM OXIDE ON HIGH TEMPERATURE VOLATILIZATION OF Nb, Ta, AND Ti OXIDES. Segui, Marcelle; Trombe, Felix (CNRS, Montlouis, France). Compt. Rend., Ser. C, 267: 1039-42(Oct. 21, 1968). (In French).

The volatilization at 2600°C of binary mixtures of $La_2O_3-Nb_2O_5$, $La_2O_3-TiO_2$, and $La_2O_3-Ta_2O_5$ showed, in each of these cases, a stable association at high temperature and of low volatility, acting as an azeotropic mixture. On both sides of these single compositions there are unique separations, which prevent the prediction of the respective volatilities of the constituents. (tr-auth)

12421 DEGASSING KINETICS OF VANADIUM–OXYGEN SOLID SOLUTIONS. Hoerz, Gerhard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 60: 50-7(Jan. 1969). (In German).

The degassing kinetics of vanadium-oxygen solid solutions were investigated in high vacuum at 8×10^{-7} torr and in ultrahigh vacuum at 7×10^{-10} torr between 1450 and 1610°C. For this purpose, oxygenated vanadium wires of 0.5 mm dia., containing 0.15, 0.35, and 0.70 at.% O were resistance-heated. Internal friction measurements after heating served to follow the degassing process. It was found that oxygen is removed by evaporation of the volatile oxide VO, evaporation being the rate determining step. (auth)

12422 WETTING OF REFRACTORY CARBIDES WITH LIQUID METALS. Samsonov, G. V.; Panasyuk, A. D.; Kozina, G. K. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 42-8(Nov. 1968). (In Russian).

Wetting of carbides of groups IV, V, VI with melted nontransition and transition metals was studied. It was established that metals do not wet carbides of groups IV−VI, and that transition metals wet carbides of groups V and VI, but do not wet IV group of carbides. Temperature and time dependences of wetting are studied as well as the effect of porosity on a boundary angle. Wetting of refractory carbide coatings on metals with melted metals was studied. An attempt was made to explain the nature of wetting processes from the concept of electronic structure carbides and metals. (auth)

12423 ON THE FATIGUE OF WC-CO ALLOYS. Miyake, Kazuo; Fujiwara, Yoshio; Nishigaki, Kenichi (Mitsubishi Metal Mining Co., Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 1128-31(1968). (In Japanese).

The influence of cobalt content on the fatigue strength and fatigue phenomena in tungsten carbide−cobalt alloys was investigated. The test was done at 8000 rpM by using a rotating beam fatigue machine. Results obtained are as follows: (1) The S−N curves in WC−Co alloys do not show flat portions which are observed in the case of iron and steel materials. Taking $N = 10^8$ rpM for the fatigue limit, the fatigue strength increases with cobalt contents. There is a linear relation between fatigue strength and tensile strength. (2) Enlarged pictures of the fatigue fracture surface indicate that the crack runs emissively, with the stress concentration source as the central figure. Electromicrographs of the crack source neighborhood exhibit a kind of fusional structure. This fusional part may be due to the excessive stress concentration. (3) According to the results of x-ray diffraction, the binder phase transforms from γ Co (fcc) to ϵ Co (hcp) by fatigue and it's ϵ content increases with fatigue degree. (4) The coercive force increases with increasing fatigue and stress. (auth)

12424 ENTHALPY OF SOLID URANIUM DIOXIDE FROM 2500°K TO ITS MELTING POINT. Leibowitz, L.; Mishler, L. W.; Chasanov, M. G. (Argonne National Lab., Ill.). J. Nucl. Mater., 29: 244-6(Feb. 1969).

The relative heat content of solid UO_2 was determined from 2500 to 3100°K using a calorimetric technique. An equation was obtained by the method of least squares to represent the data. A clear cut identification of an expected diffuse transition was not obtained but there may be indications of an anomalous increase in enthalpy between 2800 and 2850°K suggesting the existence of a diffuse transition as does the relatively low entropy of fusion which is 5.8 eu/mole at 3123°K. (F.S.)

12425 CARBON SELF-DIFFUSION IN POLYCRYSTALLINE TUNGSTEN CARBIDE. Buhsmer, Charles Paul Jr. Albany, State Univ. of New York. Alfred, N. Y., Alfred Univ., 1968. 167p. Thesis.

Dense, hot pressed tungsten carbide specimens were used to study the self-diffusion of ^{14}C into WC. The ^{14}C was applied to the optically flat sample surface by means of a radioactive Aquadag slurry and diffusion anneals performed on the diffusion couple in purified helium atmosphere at temperatures ranging from 2238 to 2643°K. In order to minimize the mathematical assumptions in data analysis, and eliminate the necessity for very long diffusion anneals, a sub-micron sectioning technique was developed, and the diffusion penetration depth determined by spectrophotometric W^V thiocyanate analysis of the sample sections obtained. The β^- radioactivity of the sections was measured under constant geometry in a Baird-Atomic, windowless flow counter, and the activity versus penetration curves for the several runs were plotted. The existence of two clearly delineated diffusion mechanisms was demonstrated. The first obeyed a bulk diffusion law, (linear plots of ln activity versus penetration depth squared) originated at the specimen surface, showed anomalously low diffusion coefficients, ($\sim 10^{-15} cm^2/sec$) dominated to a depth of about one micron, and from an Arrhenius plot showed an apparent activation energy of 88 kcal/mole. Autoradiography demonstrated that the second mechanism was grain-boundary diffusion, and it dominated at depths of greater than one micron. The Fisher grain-boundary analysis (linear plots of ln activity versus penetration depth) and the Suzuoka analysis (linear plots of ln activity versus the $^6/_5$ power of penetration depth) gave apparent grain-boundary diffusion activation energies of 76 kcal/mole and 70 kcal/mole, respectively. The Suzuoka analysis gave values of D_{gb} ranging from 10^{-4} to 10^{-6} cm^2/sec. (Disser. Abstr.)

12426 SHOCK-WAVE COMPRESSION OF SOME INORGANIC COMPOSITIONS. Deribas, A.; Dobretsov, N.; Kudinov, V.; Maly, V.; Serebryakov, A.; Staver, A. (Inst. of Hydrodynamics, Novosibirsk, USSR. Inst. of Geology and Geophysics, Novosibirsk, USSR). pp 385-8 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

Powders of silicates and mixtures of Fe−W and C−W were investigated after shock wave compression. Data on silicate powders are tabulated. X-ray diffraction patterns are shown for Fe−W and C−W. (F.S.)

12427 MAKING THE MOST OF BERYLLIUM. Hanes, Hugh D. (Battelle Memorial Inst., Columbus, Ohio). Battelle Tech. Rev., 17: 15-19(Sept.-Oct. 1968).

Important nuclear and non-nuclear applications, characteristics, and procedures for optimizing the engineering properties of Be are discussed. Physical properties of the metal are unusual, and they can vary widely according to heat treatment, impurity content, and grain size. It is useful in nuclear applications since it has a low thermal neutron cross section and thus is essentially transparent to most forms of radiation. Mechanical properties are a function, in part, of the purity of Be. Purification increases the elongation achieved in single-crystal Be by slip on both basal and prismatic planes but will simultaneously decrease the strength. The major impurities in commercial Be have been studied in single crystals, and their effects on mechanical properties have been observed. Relatively small additions of Fe, Ni, and Cu to Be greatly increase the lattice parameter, indicating that they are also strong solid-solution strengtheners. The major inclusions in Be powder are beryllium oxide and beryllium carbide, and provide for the major microstructural difference between powder metallurgy and cast Be. A typical thermal effect in Be is the marked loss of ductility at about 600°C. Since purity, grain size, and preferred orientation, which all contribute to the mechanical properties of Be, cannot be varied independently, a variety of Be products is available. Preferred orientation is strictly a function of amount and type of fabrication. To utilize effectively the best properties of Be in structural applications, designers must understand how input materials and fabrication affect the metal's properties. (BBB)

12428 SCIENCE OF CERAMICS. VOLUME IV. Proceeding of Fourth International Conference held at Maastricht, Netherland, 23–27 April 1967. Stewart, G. H. (ed.). Sci. Ceram., 4: 1-481(1968). (CONF-670452).

Thirty-one papers were presented under the following sections: Effect of mechanical forces during heat treatment; fabrication; reactions during sintering; reactions in multiphase ceramics during firing; development of ceramics for newest applications. Separate abstracts are presented for ten of these papers. (UK)

For abstracts of individual papers see: 12406–12408, 12429–12431, and 12437–12440.

12429 DEFECT STRUCTURES IN CERAMIC MATERIALS. Roberts, L. E. J. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. Ceram., 4: 329-47(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

Special properties of different classes of ceramics have been exploited in a number of new applications over the past 20 years. The actinide dioxides provide the most important nuclear fuels and doped rare-earth and zirconium oxides are being developed for use in furnaces, MHD electrodes, fuel cells, and galvanic cells. The stability of highly defective phases derived from the fluorite structure may depend on the ability of cations having different charges to exist in a favorable local configuration in one host lattice. The phase relationships and electrical properties are determined by the tendency towards short and long-range order. Some contrasting properties of the semimetallic carbides and nitrides of the transition and actinide elements are reviewed. (auth) (UK)

12430 FUSION-CAST CARBIDE–BORIDE–GRAPHITE CERAMICS. Alper, A. M.; Doman, R. C.; McNally, R. N. (Corning Glass Works, Corning, N. Y.). Sci. Ceram., 4: 389-420(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

Fused carbides and/or borides containing free graphite are discussed. Phase assemblages, microstructures, and properties are related to compatibility and phase diagrams. The following systems are discussed: Ti−C−B, Zr−C−B. Hf−C−B, V−C−B, Cr−C−B, and W−C−B. Only the parts of these systems which contain free graphite are considered. All these bodies have excellent thermal-shock resistance. Other properties, such as electrical, thermal, mechanical, and chemical, can be modified by choosing different phase assemblages. Some of these materials have been cast into large shapes more than 18 in. long, and they can be machined into articles. (auth) (UK)

12431 PROPERTIES OF MIXTURES OF URANIUM NITRIDE AND URANIUM DIOXIDE. Moench, S.; Claussen, N. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Sci. Ceram., 4: 459-64(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

Sintering behavior, electrical conductivity, and some mechanical properties of UO_2−UN mixtures were studied. At all concentrations investigated, the system UO_2−UN consists of a heterogeneous mixture of both phases which sinter independently. The low electrical conductivity of UO_2 can be improved by additions of UN. The Young's modulus and the indirect tensile strength of UO_2−UN mixtures does not change much with composition. Sintered samples at concentrations around 30 vol % UN and 70 vol % UO_2 exhibit good electrical properties without loss of mechanical strength, so that the use of this composition may offer some advantage over the pure components. (auth) (UK)

Structure and Phase Studies

Refer also to abstracts 12287, 12340, 12346, 12364, 12366, 12416, 12418, 12428, 12430, 12443, and 13500.

12432 THE PHASE AND STRUCTURAL TRANSFORMATIONS IN THE SUPERFICIAL LAYERS OF SOLID ALLOYS OF GROUP VK UPON ELECTROSPARK TO TREATMENT. Filimonenko, V. N.; Pivovarov, B. Kh. Izv. Akad. Nauk SSSR, Metal, No. 5, 165-8(Sept.-Oct. 1968). (In Russian).

High temperatures, pressures and current densities, emerging in spark gap in the process of treating various materials generally result in strong phase and structural transformations in surface layers. An attempt was made to study the results of studies of the phase and structural transformations in the surface layers of solid alloys of WC group during electrospark treatment. (P.C.H.)

12433 ZIRCONIUM AND NIOBIUM CARBIDE BEHAVIOR IN PLASMA. Sharivker, S. Yu.; Olievskii, M. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 12, 74-81(Dec. 1968). (In Russian).

The effects of powder dispersiveness and oxygen content were examined in a gas medium on chemical and phase composition of zirconium and niobium carbides in plasma pulverization. The data obtained were compared with physico-chemical properties of carbides. The possibility is shown of obtaining zirconium carbide of a stoichiometric composition and niobium carbide on $NbC_{0.8}$ composition in plasma pulverization. Optimum dispersiveness of a pulverized powder and oxygen content in a gas medium in pulverization were chosen. (auth)

12434 TWINNING OF ERBIUM OXIDE SINGLE CRYSTALS IN THE ELECTRON MICROSCOPE. Murr, L. E. (Pennsylvania State Univ., University Park). pp 328-9 of Proceedings [of] Twenty-Fifth Anniversary Meeting, Electron Microscopy Society of America, Chicago, Illinois, August 29–September 1, 1967. Arceneaux, Claude J. (ed.). Baton Rouge, La., Claitor's Book Store, 1967.

See CONF-670819.

An intermittent flash evaporation technique was used in vaporization of Er from W boats during which tiny single crystals having various prominent surface orientations were formed in association with the Er matrix which differed significantly from the matrix. Investigations led to the conclusion that the crystals are ErO, having been formed by trapping of residual O_2 between intermittent flash evaporations of small quantities of Er, and having grown, interstitially, between two thin Er film layers with a combined thickness 650 Å. (J.R.D.)

12435 HIGH TEMPERATURE REACTIONS BETWEEN TANTALUM AND OXIDES OF URANIUM AND PLUTONIUM. Batey, W.; Bramman, J. I.; Irons, H. W.; Yates, G. (United Kingdom Atomic Energy Authority, Thurso, Scotland). J. Nucl. Mater., 29: 229-34(Feb. 1969).

Mechanisms of the reaction between Ta and oxides of U and Pu were investigated. Reactions proceed by a solution mechanism characterized by a minimum reaction temperature that is dependent upon oxide composition. Tantalum taken into solution in the oxide at high temperatures is re-precipitated on cooling, leaving in solution in the oxide, an amount of Ta which is also dependent upon the original oxide composition. (F.S.)

12436 PHASE TRANSITIONS IN SOLIDS INDUCED BY SHOCK WAVES. Ruchkin, F. D.; Ovsyannikova, I. A.; Batsanov, S. S. (Thermal Physics Inst., Novosibirsk, USSR). pp 361-5 of Behaviour of Dense Media Under High Dynamic Pressures. New York, Gordon and Breach, 1968.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France. See CONF-670914.

Polymorphous conversions in rare earth metal (REM) oxides and phase transitions in REM, Th, and U fluorides induced by shock waves were investigated. Properties of dynamically compressed oxides change according to the degree of conversion from the monocline B-form to the C-form. In investigating different properties in CeF_4, HfF_4, ThF_4, UF_4, and ZrF_4, significant γ property changes were noticed only in ThF_4 and UF_4. In the study of effects of shock waves in powders of anhydrous REM fluorides it was found the CeF_3 and PrF_3 did not display the same behavior as LaF_3 and NdF_3. In the investigation of phase transitions, the crystalloptical analysis proved to be the most convenient and sensitive method of investigating new phases. (F.S.)

12437 INVESTIGATIONS OF STRUCTURE TRANSFORMATIONS IN REFRACTORIES ABOVE 2000°C. Foex, M. (Centre National de la Recherche Scientifique, Montlouis, France). Sci. Ceram., 4: 217-31(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

By combining the use of a solar furnace or plasma centrifuge with thermal analysis, the high-temperature crystal forms of refractory oxides which normally do not persist after quenching can be investigated under the conditions of their formation. Arrests in the cooling curves of zirconia and the rare-earth oxides were detected and the crystal conversions identified. The effects of additives on the cubic-tetragonal transformation of zirconia about 2300°C, and the ranges of the hexagonal (A), monoclinic (B), and the cubic (C) modifications of the rare-earth sesquioxides were determined. Two new modifications of the latter oxides which are stable above 2000°C were identified: the first, a hexagonal form (H), which relates to all the sesquioxides except the last of the series; the other, a cubic form (X) which relates to the first few oxides only. The conversion from one form to the other was studied and similarities noted between $A \rightleftharpoons H$ transformation in these oxides and the $\alpha \rightleftharpoons \beta$ transformation in quartz. (auth) (UK)

12438 INFLUENCE OF ADDITIONS OF RARE-EARTH OXIDES ON THE POLYMORPHISM OF ZIRCONIA AND HAFNIA. Koehler, E. K.; Glushkova, V. B. (Inst. of Silicate Chemistry, Leningrad). Sci. Ceram., 4: 233-45(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

Additions of oxides of the rare-earth elements to zirconia led to the development of solid solutions of these elements in zirconia and considerably decreased the temperature of the monoclinic–tetragonal transformation. The method of preparation of the initial mixture influenced the properties of the product obtained. In the co-precipitation method a metastable solid solution developed as an intermediate product. The mechanism of separation of the metastable solid solution into stable phases was studied. Investigation of a number of $ZrO_2-M_2O_3$ systems (where M is a rare-earth element) enabled the phase relationships in the regions rich in zirconia, and also the minimum additions of rare-earth elements necessary to stabilize zirconia, to be defined. The HfO_2-rich and ZrO_2-rich regions of the $ZrO_2-M_2O_3$ and $HfO_2-M_2O_3$ systems were compared. (auth) (UK)

12439 ZIRCONIA SOLID SOLUTIONS WITH RARE-EARTH OXIDES. Spitsbergen, U.; Houpt, P. M. (TNO, Delft, Netherlands). Sci. Ceram., 4: 247-54(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

An arc-melting procedure was studied for the rapid heating of mixtures of zirconia and rare earth oxides. The oxides of each element of the rare earth series, except Pm, were investigated. The products of melting were examined by x-ray powder diffraction and by x-ray fluorescence methods. The hardness of some of the products was measured. (auth) (UK)

12440 REACTIONS BETWEEN NICKEL AND THE CARBIDES AND NITRIDES OF URANIUM AND THEIR SOLID SOLUTIONS. Passefort, J. C.; Anselin, F.; Calais, D. (CEN, Fontenay aux Roses, France.). Sci. Ceram., 4: 421-57(1968).

From 4th International Conference on Science of Ceramics, Maastricht, Netherlands. See CONF-670452.

Nickel reacts with uranium monocarbide to give, according to the proportions present, the mixed carbides UC_2Ni or U_2C_3Ni and various compounds in the system U–Ni. For example $2\ UC + 6\ Ni \rightarrow UNi_5 + UC_2Ni$ between 900 and 1300°C. At low temperature this reaction is replaced by $UC + 5Ni \rightarrow UNi_5 + C$, UC_2Ni not being formed for kinetic reasons. The sesquicarbide reacts directly with nickel: $U_2C_3 + Ni \rightarrow U_2C_3Ni$. The UNi_5, UC_2Ni, U_2C_3Ni have been identified by the x-ray pattern and by microanalysis. UC_2Ni is simple tetragonal (a = 4.961 Å, c = 7.346 Å). U_2C_3Ni has a complex structure. The presence of graphite has been shown by means of carbide labelled with ^{14}C. Nickel reacts with uranium nitride according to the reaction: $UN + 5Ni \rightleftharpoons UNi_5 + \frac{1}{2}N_2$ accompanied, depending on the nitrogen pressure exerted, by the formation of sesquinitride: $2UN + \frac{1}{2}N_2 \rightleftharpoons U_2N_3$. An upper limit of the free energy of the compound UNi_5 has been evaluated: $G_{UNi_5} - 41{,}600$ cal. + 5.1 T°K. U(CN) solid solutions react with nickel similarly, although some reactions observed with the U(CN)–Ni diffusion couples have an incubation period because the free energy of UN or of UC decreases in solid solution. Anisotropic reactions have also been observed in UC–Ni and U(CN)–Ni couples due to the presence of submicroscopic particles of a second phase, UC_2, epitaxially on the (100) planes of carbide or carbonitride. Uranium diffuses chemically in nickel according to: $D_{UNI} = 137\ cm^2 s^{-1} \cdot e^{-67{,}000\,cal/RT}$ (auth) (UK)

Radiation Effects

Refer also to abstracts 12413, 12419, 13503, 13504, and 13506.

12441 (BNWL-SA-2030) NONSTOICHIOMETRY EFFECTS ON THE MICROSTRUCTURE OF IRRADIATED UO_2–25 WT PERCENT PuO_2 FUELS. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1, 1968. Contract AT(45-1)-1830. 12p. (CONF-681101-8). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Variations in the microstructure of irradiated UO_2–25 wt % PuO_2 correlate systematically with oxygen content in the interval $1.95 \leq O/M \leq 2.00$. Twelve fuel pins were irradiated with center temperatures near melting. Irradiation conditions achieved structural and compositional steady states which were retained by rapidly quenching the specimens from peak power. Metallography, beta and gamma autoradiography, electron microscopy, x-ray diffraction, and electron-beam micro-analysis were employed in characterizing the postirradiation fuel structures. (J.C.W.)

12442 LATTICE PARAMETER AND DIMENSIONAL CHANGES IN GRAPHITE IRRADIATED BETWEEN 300 AND 1350°C. Henson, R. W.; Perks, A. J.; Simmons, J. H. W. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 6: 789-806(Dec. 1968).

The changes in lattice parameters and dimensions of graphite irradiated in the range 300 to 650°C up to a dose of 5×10^{21} n/cm² have been attributed to four types of radiation defect. These are vacant lattice sites, interstitial loops, vacancy lines, and vacancy loops. Evidence for the occurrence of these defects is discussed and their concentrations were determined from the experimental data. The values obtained were used to check theories of the nucleation and growth of interstitial loops and vacancy lines. Graphite was also irradiated to high doses in this temperature range in the DFR and at higher temperatures to somewhat lower doses in the reactor PLUTO. Quantitative analysis was not possible under these conditions, but qualitative interpretations of the behaviour are put forward. (auth) (UK)

12443 CHANGES IN THE MICROPOROSITY OF PURIFIED NUCLEAR GRAPHITE DURING THERMAL AND RADIOLYTIC OXIDATION. Lang, F. M.; Blanchard, R.; Fessler, J. C. (CEN, Saclay, France. CEN, Grenoble, France). Carbon, 6: 827-40 (Dec. 1968). (In French).

The changes in the porous microtexture of purified nuclear graphite during thermal and radiolytic oxidation were followed by small-angle x-ray scattering and by capillary condensation. Both methods were found to be informative. In the case of thermal oxidation at 620°C in air, the pores mainly affected by the corrosion were those of radius smaller than 0.5 μ. However, when moisture was present, the oxidation led to a faster opening of micropores inaccessible to gases. For irradiation in a CO_2 atmosphere, corrosion under the experimental conditions was chiefly confined to pores of radius between 1 and 10 μ and seem to be related, for this range, to the volume of gas contained in the pores. Striction observed in the micropores resulted from the action of fast neutrons. It is probable, however, that a corrosion process is superimposed on the neutron effect. (auth)(UK)

12444 SOLID FISSION PRODUCT BEHAVIOR IN URANIUM–PLUTONIUM OXIDE FUEL IRRADIATED IN A FAST NEUTRON FLUX. O'Boyle, D. R.; Brown, F. L.; Sanecki, J. E. (Argonne National Lab., Ill.). J. Nucl. Mater., 29: 27-42(Jan. 1969).

A UO_2-20 wt % PuO_2 fuel pin irradiated in a fast neutron flux to a burnup of 5.6×10^{20} fissions/cm^3 was examined by means of electron-microprobe analysis. Two separate types of solid-fission-product inclusions were identified. White metallic inclusions, located in both the equiaxed- and columnar-grain regions, that contained molybdenum, technetium, ruthenium, rhodium, and palladium, and a grey phase, located in the equiaxed grain region, that contained strontium, barium, and cerium were identified. The concentrations of molybdenum, technetium, and ruthenium, measured in 42 white metallic inclusions in the columnar-grain region, were found to vary with radial location. The observed partition of solid fission products between the oxide matrix and the inclusions is in agreement with predictions based on the free energy of formation of the fission-product oxides and the oxygen balance between that liberated by the fission process and that required to form stable fission-product oxides. Measurements of the radial distribution of uranium and plutonium confirmed the migration of plutonium up the temperature gradient. (auth)

12445 ANISOTROPIC GROWTH OF ALUMINIUM NITRIDE UNDER NEUTRON IRRADIATION. Hickman, B. S.; Jostsons, A. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). J. Nucl. Mater., 29: 121-2(Jan. 1969).

The results of anisotropic lattice growth in BeO and ZnO under neutron irradiation have been reported previously. The growth has detrimental effects on the properties of polycrystalline material. Single crystal whiskers of aluminum nitride were neutron irradiated to a range of fast neutron doses at 75 to 100°C in the reactor HIFAR. The results are reported and show that the aluminum nitride lattice growth is highly anisotropic. (J.C.W.)

Plastics and Other Materials

Refer also to abstracts 11721, 12345, and 13503.

12446 (UCRL-71353) CONTROLLED-TRANSIENT TECHNIQUE FOR MEASURING RADIATION-INDUCED CONDUCTIVITY IN DIELECTRICS. Winslow, John W. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 8, 1968. Contract W-7405-eng-48. 15p. (CONF-681026-1). Dep. CFSTI.

From Conference on Electric Insulation and Dielectric Phenomena, Buck Hill Falls, Pa.

Radiation-induced conductivity in dielectrics was studied using the behavior of polyethylene and polystyrene during irradiation. Measurements were made under constant irradiation (about 50 rad/sec ^{60}Co gammas) with electric fields limited to the range below about 50 kV/cm. The two materials were found to display a type of volume photoconductivity which may be useful in examining conduction mechanisms and related internal phenomena. Mechanisms responsible for observed currents are not obvious but they are shown to be insensitive to trace elements and minor constituents. Small sensitivity to neutron bombardment suggests structural imperfections present in large concentration. (F.S.)

12447 COATING FORMULATION AND PROCESS. Burlant, William Jack (to Ford Motor Co.). British Patent 1,138,117. Dec. 27, 1968. Filed Feb. 14, 1967.

A process is described for coating a substrate, comprising the steps of applying a film of a liquid film-forming composition consisting of an olefinically unsaturated polyester resin and a monomeric vinyl compound of lower viscosity than the resin, and copolymerizing the resin and the vinyl monomer upon the substrate by ionizing radiation while maintaining the film at a temperature below that at which significant vaporization is initiated. The preferred resins are prepared by copolymerizing a polyhydric alcohol, an acyclic, alpha-unsaturated, alpha-beta dicarboxylic acid, and a cyclic, aliphatic, dicarboxylic acid. Cyclic dicarboxylic acid makes up a major amount by weight of the acid component, the acyclic dicarboxylic acid makes up a minor amount of the acid component, and the polyhydric alcohol is a cyclic glycol. The vinyl monomer component may consist of a single component or may be a mixture of more than one monomeric compound. Liquid films of the binder solutions can be applied as a thin film (of up to 4 mils) by conventional methods and cured at relatively low temperatures. (UK)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

12448 ^{244}Pu IN THE EARLY SOLAR SYSTEM. Sabu, Dwarka Das. Fayetteville, Ark., Univ. of Arkansas, 1968. 81p.
Thesis.

Existence of ^{244}Pu and ^{129}I in the early solar system was exploited for calculation of formation (or decay) intervals of various achondrites and chondrites. The Pu/Xe and I/Xe decay intervals are concordant for most of the achondrites and possibly same is the case for chondrites. The initial abundances of ^{244}Pu and ^{129}I needed to obtain concordancy support "continuous synthesis" model of galactic nucleosynthesis. The "single-event" model completely destroys the concordancy and offers several other difficulties. The problem of excess fission xenon in chondrites, which gave rise to high initial abundance of ^{244}Pu was restudied. It was found that most of the excess fission xenon in ordinary chondrites is due to presence of an atmospheric-type component, possibly due to contamination. The Bruderheim chondrite contains about 1×10^{-12} cc STP/g of fissiogenic ^{136}Xe, and none of the other chondrites except carbonaceous chondrites seem to contain much greater amounts of fission xenon than this. From the experimental data obtained in different laboratories, the following average values were obtained for the Bruderheim meteorite: $^{136f}\mathrm{Xe} = 1.06 \times 10^{-12}$ cc STP/g; $^{129r}\mathrm{Xe} = 41 \times 10^{-12}$ cc STP/g; I = 19 ppb; U = 11 ppb. The above values yield the Pu/Xe and I/Xe decay intervals of 142×10^6 years and 136×10^6 years respectively, if the initial ^{244}Pu/^{238}U and ^{129}I/^{127}I ratios immediately after cessation of nucleosynthesis were 0.0235 and 0.0030, respectively. The various mechanisms for production of xenon anomalies in the atmosphere were reviewed and a mechanism is suggested which explains the anomalous ^{131}Xe and ^{132}Xe on the basis of spontaneous fission of ^{244}Pu. The isotopic ratios of primordial xenon were computed on the basis of the abundance of light isotopes of xenon in atmosphere and heavy isotopes in 600°C fraction of Renazzo meteorite. It is suggested that abundance of cosmic-ray-produced xenon isotopes differs from meteorite to meteorite. (Diss. Abstr.)

Stars

Refer also to abstracts 12670, 13002, 13008, and 13134.

12449 A COMPARISON OF THE SPECTRA OF C AND M GIANTS AT ONE MICRON. Fay, Theodore Denis Jr. Bloomington, Ind., Indiana Univ., 1968. 288p.
Thesis.

Spectra of two M supergiants — α Sco and R Hya — and five carbon stars — RY Dra, Y C Vn, W Ori, RS Cyg, and U Cyg — were photographed from 1.00 to 1.09 micron (reciprocal dispersion, 45 A/mm) using image tubes. These spectra were compared with the one-micron spectra of Y C Vn and α Ori photographed with I–Z plates by Wyller and Spinrad. (TSS) (Disser. Abstr.)

12450 PULSATIONAL PROPERTIES OF A MASSIVE STAR IN THE HELIUM BURNING PHASE. I. Prasad, C.; Mohan, C. (Univ. of Roorkee, India). Mon. Notic. Roy. Astron. Soc., 141: 389-95(1968).

Using the eigenvalues of parameters as given by Hayashi and Cameron (1962), the detailed inner structure of a 15.6 $M_\odot$ star in the helium-burning phase of its evolution was obtained. The stellar model was then studied for its small adiabatic radial oscillations. The effect of radiation pressure and its variation through the star on the periods and amplitudes of pulsation was also studied. (auth) (UK)

12451 OBSERVATIONAL TESTS FOR ELEMENT SYNTHESIS IN MASSIVE OBJECTS. Pagel, B. E. J. Quart. J. Roy. Astron. Soc., 9: 401-8(Dec. 1968).

Possible difficulties in explaining the presence of heavy elements in the galactic halo and certain other systems (e.g. quasars) on the basis of synthesis in conventional stars inspired investigations by Wagoner, Fowler, and Hoyle (1967) of nuclear reactions in supermassive objects. Detailed comparison of their predictions with abundances observed in certain extremely metal-deficient stars of the galactic halo, however, suggests that the theory of synthesis in stars still appears to be the most promising for these objects. (auth) (UK)

12452 UBV OBSERVATIONS OF SELECTED DOUBLE SYSTEMS. Landolt, Arlo U. (Louisiana State Univ. Observatory, Baton Rouge. Cerro Tololo Inter-American Observatory, La Serena, Chile). Publ. Astron. Soc. Pac., 80: 749-51(Dec. 1968).

UBV magnitudes and color indices were obtained for eleven double systems listed in the Catalogue of Bright Stars for which these data have been lacking. (auth)

12453 FURTHER BRIGHT PECULIAR A STARS. Cowley, A. P. (Univ. of Michigan, Ann Arbor); Cowley, C. R.; Hiltner, W. A.; Jaschek, M.; Jaschek, C. Publ. Astron. Soc. Pac., 80: 746-9(Dec. 1968).

The completion of the observation and reclassification of the A stars in the Bright Star Catalogue has lead to the recognition of additional new peculiar and metallic-line A stars. These stars are listed with their new classifications. (W.D.M.)

12454 THREE RED STARS. Catchpole, R. M. (Radcliffe Observatory, Pretoria). Publ. Astron. Soc. Pac., 80: 744-6 (Dec. 1968).

Spectrograms of the very red star in Vela, a companion of β Crucis, and an anonymous red star were obtained with the f/1 camera at the Cassegrain focus of the Radcliffe 1.88-m reflector. The positions of the stars and details concerning the spectrograms are given. The spectrograms have a dispersion of 545 Å/mm at the NaD lines. (W.D.M.)

12455 THE EFFECT OF METAL ABUNDANCE ON K-LINE ABSOLUTE MAGNITUDES. Yoss, Kenneth M.; Lutz, Thomas E. (Univ. of Illinois Observatory, Urbana). Publ. Astron. Soc. Pac., 80: 717-38(Dec. 1968).

The possible influence of variation in stellar metal abundance on K-line absolute magnitudes was investigated. Using a small sample, a weak correlation was found between the difference in trigonometric and K-line absolute magnitudes, ΔM_v, and [Fe/H]. However, larger samples, using ultraviolet excesses and CN anomalies, showed no correlation. Luminosity-sensitive line ratios show better agreement between trigonometric and K-line absolute magnitudes when an abundance effect is assumed. (auth)

12456 THE SPECTRAL ENERGY DISTRIBUTION OF FG SAGITTAE. Roark, T. P. (Ohio Wesleyan, Delaware. Ohio State Univ., Columbus). Publ. Astron. Soc. Pac., 80: 712-16 (Dec. 1968).

The spectral energy distribution of the variable FG Sagittae was determined for three nights in October 1966. Using the Barbier–Chalonge Balmer discontinuity criterion (Chalonge 1956), a spectral type of A3-4 Ia is indicated for that date. (auth)

12457 FIELD OF NOVA V368 AQUILAE 1936. Klemola, A. R. (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac., 80: 706-11(Dec. 1968).

The nova V368 Aql 1936 has been identified tentatively with a faint star of magnitude 17 to 18 on a Lick proper-motion program plate. The differences between the position of the faint star and the measurements of position made in 1936 are 1.5″ in right ascension and 0.4″ in declination which are within the errors of measurement. (auth)

12458 AN INVESTIGATION OF THE EXCITATION CONDITIONS OF [OI] AND [NII] IN PLANETARY NEBULAE. Campbell, Warren A. (Washington State Univ., Pullman). Publ. Astron. Soc. Pac., 80: 689-705(Dec. 1968).

A survey of OI and NII intensities in planetary nebulae was carried out to find objects with strong OI lines, and in order to investigate a suspected correlation between the intensities of OI and NII. OI λ6300 and NII λ6583 were measured relative to Hα for 16 and 18 planetaries respectively. These observations are combined with model nebular calculations, based, primarily, on the theory of hydrogen-line and forbidden-line emission developed by Seaton, in an attempt to explain qualitatively the presence of strong OI lines in several planetaries. It is concluded that planetaries are similar to Strömgren spheres except that they are usually gas-bounded rather than radiation-bounded. Those planetaries with strong OI lines are more nearly radiation-bounded than those with weak OI lines. The planetary nebula models also give an explanation of the correlation between the intensities of OI λ6300 and NII λ6583. (auth)

12459 CHANGING SPECTRA OF FOUR SHELL STARS. Cowley, A. P. (Univ. of Michigan, Ann Arbor); Hiltner, W. A. Publ. Astron. Soc. Pac., 80: 685-8(Dec. 1968).

Several spectrograms were obtained over the past four years of HR 716(A), HR 2174(A), 4 Her, and HR 9094(B). All except HR 716(A) have previously been recognized as shell or shell-like stars. All four stars show spectral variations. Some comments are made about the little-known A-type shell stars which may be more numerous than has been thought. (auth)

12460 UBV OBSERVATIONS OF LONG-PERIOD VARIABLE STARS. V. Landolt, Arlo U. (Louisiana State Univ. Observatory, Baton Rouge. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac., 80: 680-4(Dec. 1968).

Photoelectric observations of 36 long-period variable stars are presented on the UBV photometric system. (auth)

12461 COLLISION STRENGTHS AND PHOTOIONIZATION CROSS SECTIONS FOR NITROGEN, OXYGEN, AND NEON. Henry, Ronald J. W. (Kitt Peak National Observatory, Tucson, Ariz.); Williams, Robert E. Publ. Astron. Soc. Pac., 80: 669-79(Dec. 1968).

Collision strengths and photoionization cross sections for atoms and ions of nitrogen, oxygen, and neon, with configurations $1s^2 2s^2 2p^q$, are fitted to interpolation formulae. These formulae give the effective collision strengths of N^0 and O^0 as a function of temperature, and photoionization cross sections as a function of frequency. The close coupling approximation is used to obtain collision strengths for ions of neon, and photoionization cross sections for N^+, O^{++}, Ne^+, Ne^{++}, Ne^{3+}, and Ne^{4+}. The remaining data are quoted from previous calculations in which the same method of computation was used. A comparison is made between the present results for collision strengths and those using the exact resonance and distorted-wave approximation. (auth)

12462 HIGH-DISPERSION INFRARED IMAGE-TUBE SPECTROSCOPY WITH A SMALL TELESCOPE. Wood, H. John (Univ. of Virginia, Charlottesville). Publ. Astron. Soc. Pac., 80: 647-53(Dec. 1968).

Observations of α Sco and α Boo in the λ8500 spectral region at a reciprocal dispersion of 8 Å/mm are described. The λ8498 Ca II line in α Sco shows an asymmetrical profile which suggests emission in a circumstellar envelope. A compositing technique is shown which greatly improves the resolution of image-type spectrograms. (auth)

12463 THE FIFTH STATE OF MATTER: ON SUPER-DENSE MATTER AND NEUTRON STARS. Kuchowicz, Br. (Univ. of Warsaw). Sci. Progr. (London), 56: 531-9(1968).

Some theoretical developments are described which have led to the belief in the existence of super-dense matter, with densities of the order of 10^{15} g/cm^3. Such matter cannot be produced in terrestrial laboratories; it may, however, be present in the central regions of neutron stars. In the study of super-dense matter Einstein's general theory of relativity connects with nuclear physics. In the super-dense state the usual atomic structure is destroyed and a macroscopic bulk of matter consisting of nucleons is stabilized by an interplay of gravitational and nuclear forces. (auth) (UK)

12464 DYNAMICS OF VARIABLE STARS. Christy, R. F. (California Inst. of Tech., Pasadena). SIAM (Soc. Ind. Appl. Math.) Rev., 10: 291-302(July 1968).

The physical system of Cepheid variable stars is considered, and the coupled equations of spherical hydrodynamics and radiation diffusion were solved numerically as an initial value problem for a variety of stellar models. The star is a spherical mass of gas, primarily a mixture of H and He, which is contained by its self-gravitation. A temperature gradient and flow of heat from the interior to the surface are maintained by nuclear reactions in the hot central region. The exterior surface is a free surface which radiates the heat arriving from the interior. The surface temperatures of the Cepheid variables are in the range from 4000 to 8000°K where the principal gases are primarily un-ionized and atomic. Unstable models show a growing amplitude of pulsation which ultimately levels off at a stable maximum amplitude of periodic motion. This final motion and the associated large amplitude light variation agreed closely with observed variables. Calculations show that the results are reliable. The interior dynamics were examined to determine the physical cause of the instability and also to understand peculiar secondary features of the pulsation. In addition, overtone pulsation in the first radial overtone was studied. In a few cases, the instability can lead to stable large amplitude periodic motion in either the fundamental or the first overtone, depending on the initial conditions. (BBB)

12465 PROBLEM OF THE SITE AND ASSIGNMENT OF THE BLUE OBJECT IN THE TWO-COLOR DIAGRAM. Richter, N. Monatsber. Deut. Akad. Wiss. Berlin, 10: 578-80(1968). (In German).

Ninety-three of the 103 quasi-stellar objects can be arranged in a two-color diagram. An examination of the diagram confirms that it is a question of blue objects which show a negative U−B. The point cloud of the diagram is concentrated in an almost circular symmetrical range, which is cut by the two-color line of the black bodies. Objects to the right of the two-color line of the black bodies, were characterized as extragalactic. Objects to the left of the two-color line are in the category of white dwarfs and are in the Galaxy. (J.S.R.)

12466 EQUILIBRIUM AND OSCILLATIONS OF COMPRESSIBLE POLYTROPIC CYLINDERS IN ROTATION. Robe, Henri (Univ., Liege). Ann. Astrophys., 31: 549-58(Nov.-Dec. 1968). (In French).

In order to determine the possible effects of rotation on the oscillations of a star, the equilibrium and the pseudo-radial and nonradial adiabatic oscillations of uniformly rotating infinite cylinders, with pressure and density related by the equation $p = K\rho^{1+1/n}$, were investigated. The Emden equation governing the equilibrium of such cylinders was solved numerically in the cases n = 1, 3, and 6 for values of the angular velocity, Ω, running from zero to the maximum value consistent with equilibrium. The variation of their radius and ratio of axial to mean density per unit length is shown as a function of Ω^2. The fundamental and first few radial and pseudo-radial modes were considered first. Eigenvalues for the cylinders n = 1 and various values of the ratio, γ, of specific heats ($\gamma = 5/3$; $\gamma = 4/3$; $\gamma = 1$; $\gamma = 0{,}5$) and the eigenvalues for n = 3 and 6 when $\gamma = 5/3$ are given. It is concluded that a rotational motion always increases the dynamical stability towards radial perturbations. Finally, the p_2, p_1, f, g_1, and g_2 nonradial modes of the cylinders n = 1 and 3 were studied when $\gamma = 5/3$. It was found that a rotational motion lifts the twofold degeneracy of those eigenvalues, but never removes the instability of convective origin exhibited by the g modes: the eigenvalues, $\sigma = \sigma_1 + i\sigma_2$, of these modes remain complex whatever the angular velocity of the cylinder. This conclusion is quite different from that reached by studies of the homogeneous model and indicates that the compressible Maclaurin spheroid could be misleading for the study of the convective g modes of rotating stellar models. (auth)

12467 X-RAY EMISSION ON ACCRETION OF INTERSTELLAR MATTER BY NEUTRON STARS. Amnuel, P. R.; Guseinov, O. Kh. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 70-4(1968). (In Russian).

The number of hypothetical neutron stars available for observation as a result of accretion is estimated at 10^4. The x-ray emission maximum is found at $\lambda = 23$ Å (with the red shift being taken into account). Thus a number of the x-ray point sources can be identified with gaseous clouds and nebulae on the assumption that the x-ray emission is caused by accretion of interstellar gas by a neutron star. The coordinates of a number of x-ray sources are related to the coordinates of gaseous nebulae. It is expected that future discoveries of x-ray emitters will be found in those regions of the sky where radio observations indicate the presence of neutral hydrogen clouds. Because of the presence of a magnetic field at the surface of a neutron star, it is shown that part of the energy of an incident charged particle (electron, or even a proton at high magnetic fields) is dissipated in the form of synchrotron radiation. This synchrotron emission will continue as long as the magnetic field of the neutron star is not weakened (~10^6 years). (TTT)

12468 RESEARCH AND STUDY OF DEFINABLE WINDOWS OF THE BACKGROUND CONTINUUM OF SOME STARS OF DIFFERENT SPECTRAL TYPE. Humbert, J.; Rozis-Saulgeot, A.-M. (Faculte des Sciences, Besancon, France). Ann. Astrophys., 31: 589-96(Nov.-Dec. 1968). (In French).

The study of stellar continua is often carried out with rather low-dispersion spectrographs: the problem is therefore to find spectral regions where one can expect to reach the continuum or to get close enough to it. A systematic study was undertaken of these "windows" for different spectral types (B 0.5 V; A 0 IV; A 5 V; F 2 IV, and G 0 V). An attempt was made to determine their position in the spectrum and to define a number of figures of merit: width, depth. These results were used to determine the gradients of some stars. (auth)

12469 OBSERVATIONS OF THE RATIO H_α N II BY AN INTERFEROMETRIC METHOD: APPLICATION TO THE ROSETTE NEBULA. Mein, N. (Institut d'Astrophysique, Paris). Ann. Astrophys., 31: 579-87(Nov.-Dec. 1968). (In French).

Some plates of the Rosette Nebula taken with the interferometric method proposed by Courtès (1960) were studied. A method of analysis, valid for rather wide apparatus functions is given. Equivalent width of the H_α and N II lines were compared and T_e was evaluated from the H and N II populations and a model of the ionization in the Nebula. The mean T_e was 6000°K with large fluctuation around this value. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 13008.

12470 (NP-17750) INDUCED COMPTON EFFECT IN PLASMA AND ELECTROMAGNETIC WAVES UNDER ASTROPHYSICAL CONDITIONS. Preprint No. 154. Tsytovich, V. N.; Chikhachev, A. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 34p. (In Russian). Dep.

Effects of induced dispersion of plasma waves into electromagnetic waves and of electromagnetic wave scattering on relativistic electrons were investigated. It is shown that the induced effects resulted in amplification of high-frequency electromagnetic waves when the distribution of relativistic electrons was anisotropic. At high density of relativistic electrons, the induced effects resulted in effective acceleration due to the simultaneous effects of electromagnetic and plasma waves. The acceleration effect grows proportionally to the square of particle energy and compensates losses related to the Compton effects. Under certain conditions, the self-consistent distribution of relativistic electrons and electromagnetic emission produced a relativistic electron power spectrum with exponent $\gamma = 3$. An equation was obtained for γ and studies were made of γ as a function of the magnetic energy $H^2/8\pi$, in relation to the plasma energy density. Problems of high-frequency radio emission from cosmic objects were analyzed and explanation given for the power character of their spectra. Problems related to emission spectra of quasars and new objects with strong radio emission are discussed. (tr-auth)

12471 NUMBER COUNTS OF EXTRAGALACTIC RADIO SOURCES. Ringenberg, R.; McVittie, G. C. (Univ. of Illinois, Urbana). Mon. Notic. Roy. Astron. Soc., 142: 1-9(Jan. 1969).

The theoretical number count formula in a zero-pressure model universe is deduced. The sources have an arbitrary luminosity function and an arbitrary evolution function. Differential number counts and the differential index are deduced from the number count formula. It is shown numerically that, in the model universes considered, significant departures from the value $^5/_2$ for the differential index occur even at relatively small red shifts. (auth) (UK)

12472 DISCRETE X-RAY SOURCES AND THE DIFFUSE X-RAY BACKGROUND. Silk, J. (Cambridge Univ., Eng.). Nature (London), 221: 347-8(Jan. 25, 1969).

It was suggested that the isotropic x-ray background can be accounted for by means of the superposed contributions from extragalactic x-ray sources, provided that evolutionary effects are taken into account; neglect of evolutionary factors leads to a diffuse x-ray flux from discrete extragalactic sources which falls short of the observed flux by between one and two orders of magnitude. The present communication discusses the evolutionary requirements and indicates how the discovery of an isotropic flux of soft x rays, and a possible change in spectral index of the diffuse x-ray background between 10 and 100 keV, may be interpreted in a discrete source model. Difficulties involved in a proposed model of extragalactic x-ray sources as superpositions of galactic x-ray sources are also examined. A reasonable interpretation of the density evolution of powerful radio sources is that normal galaxies pass through an early phase of enhanced activity, involving an increased rate of supernova explosions. These would account for the increase in number density of the powerful radio and optical sources with red shifts, and also give rise to Crab-type x-ray sources. The interpretation of powerful radio sources in terms of a phase of enhanced radio emission by normal galaxies is considered, together with the associated x-ray emission on the assumption that the x-ray luminosities of the galaxies evolve similarly with epoch. A possibility might also be that x-ray luminosities evolve more rapidly with epoch than do radio luminosities, although there is observational evidence against this. The possible role of Scorpio-type x-ray sources in normal galaxies is considered; the isotropic soft x-ray flux at 0.25 keV may possibly be due to a population of red shifted Scorpio-type x-ray sources, and if this were the case it would be anticipated that nearby radio galaxies might be strong x-ray emitters. Evolutionary effects might reduce the luminosity requirements by an order of magnitude or more. A test that the discrete source model must satisfy is explanation of the apparent steepening of the diffuse x-ray spectrum above about 50 keV, and it is difficult to see how this effect can be explained in a discrete source model. The spectral index α of the diffuse background between 1 and 50 keV is 0.7 ± 0.2, and above 50 keV is 1.2 ± 0.1. The mean value of α for Crab-type sources is estimated by consideration of the spectral indices of the galactic hard x-ray sources; the mean value for α is 1 ± 0.2 below 100 keV and 1.4 ± 0.2 above 100 keV. Recent evidence that M87 may be a source of hard x-rays is also interesting. The similarity between these various spectral indices adds credence to the possibility that extragalactic hard x-ray sources possess a similar value of α to galactic hard x-ray sources, and contribute to the diffuse background. Confirmation of quasars as hard x-ray sources might make it plausible to account for the diffuse x-ray flux by means of a density evolution of the powerful radio sources; it would then be possible to dispense with the intermediate step of evolving normal galaxies. It does not seem possible, however, to avoid the additional degree of freedom involved in specifying the evolutionary factor for discrete extragalactic x-ray sources, to enhance the x-ray background at the expense of the radio background. If a break in the diffuse x-ray spectrum between 10 and 100 keV is confirmed, attention should be paid to interpretations involving mechanisms of x-ray production operative in the intergalactic medium, rather than in distant discrete sources; one such interpretation utilises the nonthermal bremsstrahlung of low-energy cosmic rays interacting with an ionised intergalactic medium. Such a model shows promise of accounting both for the flux and the shape of the spectrum between 1 keV and 1 MeV. (UK)

12473 ABSENCE OF PULSAR CHARACTERISTICS IN X-RAY SOURCES. Friedman, H.; Fritz, G.; Henry, R. C.; Hollinger, J. P.; Meekins, J. F.; Sadeh, D. (Naval Research Lab., Washington, D. C.). Nature (London), 221: 345-6(Jan. 25, 1969).

Recent relevant work in this field is outlined, and some observations on Scorpius XR-1 are described, using the 140-ft radio telescope at Green Bank. Simultaneous total power observations were made at 234, 256, and 405 MHz, and a search for pulse-type radiation was made by computing the power spectrum from the digitised data. The best data were obtained at 234 MHz. No pulse type signals with periods in the range 0.1 to 5 sec., for which the power spectra were reliable, were detected. It is concluded that a pulsar-type phenomenon is probably not involved in Scorpius XR-1. (UK)

12474 SPECTRA OF SOME RADIO SOURCES AT CENTIMETRE WAVELENGTHS. Bridle, A. H. (Queen's Univ., Kingston, Ont.). Nature (London), 221: 348-50(Jan. 25, 1969).

It is shown from analysis of the distribution of the radio spectral index α that some sources have indices significantly lower than those of the main low frequency population, for which the mean value of α is 0.725 ± 0.11 in samples selected near 1 GHz. Studies at frequencies near 1.4 GHz provided further examples of such sources, and a survey at 5 GHz confirmed that these sources form a distinguishable spectral class. A study of a sample of the sources at 3.24, 6.63 and 10.63 GHz using the Algonquin paraboloid is described, with a view to determining their spectra at cm. wavelengths. The sources were selected with galactic latitudes >15°, so that most of them should be extragalactic, and observations were made between March and August 1968. The results are summarised in tabular form. The repeatability of the observations was tested. Intensities were measured relative to that of 3C 123 at each frequency, and effects of receiver noise, baseline fluctuations, and calibration uncertainties were taken into account. The data were combined with available data from lower frequencies in order to derive spectra over as wide a range as possible. The observed classes of spectra are described, and the four classes are interpreted on the assumption that all the sources radiate by the synchrotron mechanism. The relation between two of the classes is stated to be important for theories of formation of radio sources. It is expected that the sources could be optically identified with active objects within which generation of the relativistic gas has occurred very recently. (UK)

12475 INTERFEROMETRIC MEASUREMENT OF POLARIZATION DISTRIBUTIONS IN RADIO SOURCES. Conway, R. G.; Kronberg, P. P. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 11-32(Jan. 1969).

A new technique of measuring linear polarization is described. The Fourier synthesis of polarization distributions is discussed, and the term "complex brightness" is introduced to represent the linear polarization. The Fourier transform of the complex brightness distribution is shown to be in direct proportion to the output of an interferometer consisting of two aerials sensitive to circularly polarized radiation. The method is applied to a study of two distributed polarized sources, the Crab Nebula and 3C 315. In each case the polarization distribution at λ 21 cm in one dimension is synthesized with a resolution of 1'.2 arc; in addition a two-dimensional model is suggested for each source. (auth) (UK)

12476 GENERAL OUTLOOK ON THE QUASARS. Dallaporta, N. (Univ., Padua). pp of 1-13 of Symposia on Theoretical Physics and Mathematics. Vol. 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968.

From Symposia on Theoretical Physics and Mathematics, Madras. See CONF-670123.

The developments in the quasar field are summarized and the most outstanding features are presented. The important steps in the present knowledge of the Universe which have been accomplished by radioastronomical techniques are outlined. The local and cosmological theories of quasar origin are discussed and it is concluded that the local theory has about fallen by the wayside. (W.D.M.)

12477 REVISED SPECTRA FOR 74 RADIO SOURCES. Murdoch, H. S.; Large, M. I. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc., 141: 377-88(1968).

Flux densities at 408 MHz obtained from a fan beam survey using the E–W arm of the Molonglo radio telescope were compared with flux densities at the same frequency for a sample area of the Parkes catalogue. For strong sources the agreement is good, but for weak sources (≤5 flux units) the Molonglo flux densities are on average significantly lower than the Parkes values. The discrepancy appears to be chiefly due to a statistical effect which causes an average overestimation of the 408-MHz flux densities in the Parkes catalogue for sources where the ratio of flux density to r.m.s. error is less than about 5. This effect is quite small for the new Molonglo 408-MHz measurements, the 4C measurements and the Parkes observations at higher frequencies. Using these data revised spectra are presented for 74 sources for which the value of the spectral index has been changed by 0.2 or more. This represents more than half of the sources considered. (auth) (UK)

12478 PROPOSED TEST FOR THE RADIATION MECHANISM OF PULSARS. Good, M. L. (State Univ. of New York, Long Island). Nature (London), 221: 250-1(Jan. 18, 1969).

Comments are offered on Gold's model for pulsars (Nature 218: 731 (1968)). It is stated that the plasma currents themselves will radiate strongly if the plasma is moving with $v \approx c$, and no embedded charges are needed for the mechanism. The current loops could be replaced by magnetic dipole layers, and the relativistically moving "magnetic poles" regarded as the field source. The radiation would be coherent radiation of these poles under the centripetal acceleration of the rotation. An alternative approach is to observe that certain components of the magnetic field (the radial component in a cylindrical coordinate system) cannot maintain the co-rotation beyond the critical radius, since otherwise energy concentrations travelling at greater than the speed of light would be involved. The radial component of magnetic field will thus be continually sheared off and radiated away, forming a coherent, highly directional, highly polarized rotating beacon. Prodigious amounts of energy can be radiated in this way, since the entire energy stored in the field concentration near the poles is radiated away in the time it takes to turn through about 1 radian. A second comment is that, if this mechanism is the source of the radiation, coherence between successive pulses should prevail. Fourier analysis of the emitted radiation should be a Fourier series rather than a Fourier integral. This leads to a specific test for emission mechanisms in which a static field in the rotating frame is the source of the observed radiation. All other mechanisms will give a null result since the phase of the emitted signals will not be locked to the rotation angle of the star. The test would appear to be decisive for Gold's model. Information may also be obtained regarding the shape of the field. A third comment is that if this mechanism is correct there are many more pulsars than are observed; the only ones seen are those for which the axis of rotation is very nearly perpendicular to the line of sight. (UK)

12479 MEASUREMENT OF PULSAR DISTANCES BY GALACTIC HYDROGEN ABSORPTION. Guelin, M.; Guibert, J.; Huchtmeier, W.; Weliachew, L. (Observatoire de Meudon, France). Nature (London), 221: 249-50(Jan. 18, 1969).

The wide-band radiation from a pulsar will be absorbed near a wavelength of 21 cm by the galactic neutral hydrogen lying between the Earth and the pulsar. On the other hand, the 21-cm emission from neutral hydrogen in directions adjacent to the pulsar's position comes from the whole path length through the Galaxy. A comparison of the two types of spectra may therefore lead to an estimate of the distance to the pulsar. Absorption measurements of 11 pulsars with the transit telescope at Nancay are described. Radiation from CP 0328 was found to be absorbed by hydrogen in the local spiral arm without any significant feature corresponding to the Perseus arm. This leads to a distance estimate many times smaller than the 4 or 6 kpc implied from Jodrell Bank measurements (Nature 220: 128 (1968)). PSR 1749-28, which is a weaker pulsar near the galactic plane, did not show any absorption and hence must be located within 1 kpc. Measurements for the other pulsars did not lead to significant distance estimates. The experimental setup is described, and the results are discussed. The measurements seem to establish that CP 0328 and PSR 1749-28 are located within the Galaxy. The estimated distances are interesting, for these sources show large pulse arrival time dispersions, and consequently, are probably among the most distant. (UK)

12480 ULTRAVIOLET- AND FORBIDDEN-LINE INTENSITIES. Tarter, C. Bruce (Univ. of California, Livermore). Astrophys. J., 18: Suppl. Ser. No. 154, 1-20(Feb. 1969).

The power emitted per unit volume by thirty-five lines of astrophysical interest was computed as a function of electron temperature and density. The principal assumption made is that the lines are collisionally excited. A feature of the calculation is the utilization of Bely's improved values for the allowed-line collision strengths. The thirty-five lines include most of the ultraviolet and forbidden lines emitted by the ionized stages of carbon, nitrogen, oxygen, and neon. The results are tabulated for densities ranging from 10 to $10^{10}/cm^3$ and temperatures covering the range from 5,000 to 200,000°K. (auth)

12481 MEASUREMENT OF GAMMA RADIATION FROM THE CRAB NEBULA. Ellis, Darwin Vincent. Houston, Tex., Rice Univ., 1968. 84p.

Thesis.

The results of a balloon-borne gamma-ray experiment are presented and evaluated. The experiment was designed to search the Crab Nebula for gamma radiation theoretically predicted to emanate from this unusual object. The scintillation detector, which was arranged to reject charged particles and respond to photons of energies between 35 and 560 keV, was alternately pointed at the Crab and away from it to measure the background. The experiment was conducted on June 4, 1967. The balloon was launched from Palestine, Texas, and reached a ceiling altitude of approximately 128,000 feet. A review of proposed mechanisms for celestial gamma-ray sources is presented and discussed in connection with the results obtained from the experiment. The experimental techniques and instrumentation are briefly described. A continuum was detected in the range of 35 to 560 keV; this range extends 440 keV higher in energy than previously found. This constitutes the first positive detection of gamma radiation from a discrete source beyond the solar system. The differential energy flux is characterized by a single spectral index of 1.19 ± .08 over the entire energy range. The gamma spectrum fits well with the spectrum of soft x radiation and it can also be smoothly joined to the optical spectrum of the nebula (corrected by $A_v = 1^m.6$). Radioactivity cannot be ruled out on the basis of this measurement but upper limits have been placed on the predicted lines. The power input from radioactivity predicted on the basis of the californium hypothesis is shown to be a minor contribution to the present-day luminosity of the Crab. The most likely explanation for the measured continuum is synchrotron radiation; 2×10^{14} eV electrons in a 2×10^{-4} gauss field emit 560-keV radiation. The total energy in relativistic electrons appears to be about a factor of 30 greater than previously estimated. (Disser. Abstr.)

12482 RADIOTELESCOPES. Hachenberg, Otto (Max-Planck-Institut fuer Radioastronomie, Bonn). Bild Wiss., 5: 128-39(Feb. 1968). (In German).

The utility of radio measurements even in the study of the solar system is noted, and a few comparisons with optical astronomy are made. Construction and principles of the radio antenna are outlined. Illustrations of construction use the design of the radioastronomical arrangements at Nancay, France, and Arecibo, Puerto Rico. Problems of obtaining higher resolution are discussed; further numbers of reflectors cannot be used. A discussion of measurements by two separate stations is given to illustrate how two smaller stations can provide resolution at least as good as that from one larger station. Descriptions of antenna arrays are given, and the use of computers in analysis of data is mentioned. The 1,1-element antenna in the Netherlands and a similar model at Owens Valley, Calif., are noted, and elements of their construction detailed. Future experiments with the telescopes in construction in Bonn, Jodrell Bank, and Cambridge are suggested. (BBB)

12483 QUASARS: RIDDLE OF THE UNIVERSE. Bisnovatii-Kogan, G. S.; Komberg, B. V. (Inst. of Applied Mathematics, Moscow). Priroda, No. 6, 12-23(June 1968). (In Russian).

The history of the discovery of quasars, a description of phenomena, and current theories regarding them are discussed. The observation in 1963 of object 3C 273 and early studies on it are reviewed. The role of magnetic turbulence is discussed in relation to stabilization of the system. In addition to this primary theory, the discussions of Hoyle are noted. The relation of quasars to intergalactic space is described: problems of origins of such objects are tied to understanding of the medium between galaxies, and the influence of the medium on the radiation of quasars must be understood. Spectral modifications by the intergalactic medium are discussed. The origin of these objects and the identification of how they may be transformed into other objects are the subject of speculation; correlations with radiogalactic phenomena may be determined. (BBB)

12484 RADIOSTARS: PULSARS. Kh'yush, E.; Bell, S. Dzh., Pilkinton, Dzh. D.; Skott, P. F.; Kollins, R. E. Priroda, No. 6, 76-80(June 1968). (In Russian).

The details of the first registrations of periodic signals in the vicinity of 81.5 MHz at the Mullard Observatory are given. Precision of the period, 1.337 sec, was $10^{-5}\%$. The instantaneous width of the lines of the signal was found to be 80 ± 20 kHz. The drift of the signal frequency is related to the dispersion of the radiation. Coordinates of the sources are $\alpha_{1950} = 19^h 19^m 38^s \pm 3s$; $\delta_{1950} = 22°00' \pm 30'$. Results obtained in April 1968 in the Crimea Observatory on the star of 18th magnitude associated by the English workers with the radio source were discussed in Moscow. Phenomena associated with neutron stars and white dwarfs are implicated; the periodicity of the white dwarf is usually about 6 to 8 sec. Simultaneous interior compression and peripheral expansion could produce a period of 1 sec. Models of a surface producing such an effect are discussed. Alternately, the signals might be connected with expulsion of plasma jets from one component of a close double star. (BBB)

Solar Phenomena

Refer also to abstract 12600.

12485 THE INTERPRETATION OF THE WING OF THE SOLAR LINE Hα. Gompertz, Gillian; Hindmarsh, W. R. (Univ. of Newcastle upon Tyne, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 97-112(Jan. 1969).

Three independent sets of observations of the wing of the solar line Hα are used to deduce the populations of the $n = 2$ and $n = 3$ levels of the hydrogen atom in the solar photosphere. The populations are expressed as excitation temperatures $T_{ex}(1,2)$ and $T_{ex}(2,3)$ for the Lyman α and Balmer α lines, respectively. The deduction involves the use of calculated values of the atomic absorption coefficient for both the line and the continuum, and employs a model photosphere, but does not assume local thermodynamic equilibrium. The excitation temperatures are compared with the temperature of the model in the range of optical depths $0.2 \leq \tau \leq 1.0$. Both $T_{ex}(1,2)$ and $T_{ex}(2,3)$ are found to be equal to the model temperature within the scatter of the observations used. This conclusion, which implies local thermodynamic equilibrium for the formation of the wing of Hα, is unchanged by the substitution of a new solar model for that originally used and by the omission of the largest term in the expression for the broadening of Hα. (auth) (UK)

12486 THE ABUNDANCES OF THE ELEMENTS IN THE SOLAR PHOTOSPHERE. VII. Zn, Ga, Ge, Cd, In, Sn, Hg, Tl, AND Pb. Lambert, D. L.; Mallia, E. A.; Warner, B. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 142: 71-95(Jan. 1969).

A detailed account is presented of the limited number of Fraunhofer lines which are attributable to the heavier elements with ground state configurations of s^2, s^2p, or s^2p^2. The Oxford photoelectric spectrometer was used to obtain new measurements of the equivalent width for selected lines of Zn 1, Ge 1, Cd 1, In 1, and Tl 1. A detailed discussion is given of the available experimental and theoretical oscillator strengths. The following abundances were obtained on the standard scale where $\log N(\mathrm{H}) = 12.00$: $\log N(\mathrm{Zn}) = 4.42$; $\leftarrow \log N(\mathrm{Ga}) = 2.94$; $\leftarrow \log N(\mathrm{Ge}) = 3.32$; $\log N(\mathrm{Cd}) = 2.07$; $\leftarrow \log N(\mathrm{In}) = 1.71$; $\leftarrow \log N(\mathrm{Sn}) = 1.71$; $\log N(\mathrm{Hg}) < 3.0$; $\leftarrow \log N(\mathrm{Tl}) \lesssim 0.2$; and $\log N(\mathrm{Pb}) = 1.90$. (auth) (UK)

12487 THE ULTRAVIOLET RESONANCE LINES OF NEUTRAL HELIUM FROM THE SUN. Hearn, A. G. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 53-70(Jan. 1969).

The population densities of the bound levels of neutral helium were calculated for a 41-level model atom using recent calculations of the cross-sections for collisional excitation from the 2^3S level to the singlet levels, some of which are significant. The effect of optical thickness in the resonance lines is included and the calculation used in an interpretation of the measured intensities of the lines at 584 and 537 Å emitted by the Sun. These two intensities may be used to determine the optical thickness and electron temperature of the emitting layer for an assumed electron density. The electron temperatures obtained lie between 30,000 and 45,000°K. Additional observations are necessary to determine the electron density; two suggestions are made. (auth) (UK)

12488 CORRELATION BETWEEN ZURICH SUNSPOT NUMBER AND PROMINENCE OF JUPITER'S RED SPOT. Solberg, H. G. (New Mexico State Univ., Las Cruces); Chapman, C. R. Nature (London), 221: 352(Jan. 25, 1969).

Reference is made to Graf et al. (Nature 218: 857(1968)) in whose paper a correlation is claimed to have been found for the years 1892 to 1947, although these authors did not quantitatively establish its significance. Argyle (Nature 219: 474(1968)) found this correlation coefficient to be 0.27, and concluded that the relationship was not established. The present authors used Peek's data on the red spot prominence for the same years and found a correlation coefficient of +0.16, again concluding that the relationship has not been established. (UK)

12489 CENTRAL CONVECTION AND SOLAR NEUTRINOS. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 22: 100-1(Jan. 20, 1969).

Mixing in a convective core on a time scale that is short compared with the lifetime of ^{7}Be against electron capture would reduce the flux of neutrinos resulting from ^{8}B decay near the solar center. (auth)

12490 SOLAR WIND. Wolstencroft, R. D. (Univ. of Hawaii, Honolulu). Sci. Progr. (Oxford), 56: 511-29(1968).

The solar wind is the continual and supersonic outflow of gas from the Sun into interplanetary space; it has been extensively studied since 1962, when its existence was conclusively demonstrated from in situ measurements of the interplanetary gas. Current knowledge of the solar wind is reviewed. (auth) (UK)

12491 LASER SPARK EXCITATION SOURCE OF SPECTRA OF HIGHLY IONIZED ATOMS. Basov, N. G.; Boiko, V. A.; Voinov, Yu. P.; Kononov, E. Ya.; Krokhin, O. N.; Mandel'shtam, S. L.; Sklizkov, G. V. (Lebedev Inst. of Physics, Moscow). Rev. Roum. Phys., 13: 97-101(1968). (In Russian).

Descriptions are given of an experimental high-power laser installation operating with a gigantic pulse. The laser spark produced by focusing the laser radiation on a solid target in vacuum was used for obtaining spectra of highly ionized calcium atoms, Ca X to Ca XVI, that appear in the solar corona. The laser emission was focused on a calcium target in a vacuum by means of a lens (f of 10 cm). The spectrum was analyzed with a vacuum spectrograph with a diffraction grating with oblique incidence. From 3 to 5 pulses produced the spectrogram. Three spectrograms produced at various energy concentrations in the target were obtained by defocusing the laser beam. The intensity of the Ca X lines remain approximately constant with reduced energy, while the lines of more highly ionized Ca diminish. (R.V.J.)

12492 EFFECT OF HIGH ELECTRON–PROTON TEMPERATURE RATIOS ON THE DOUBLE SHOCK-WAVE STRUCTURE IN THE SOLAR WIND. Schubert, Gerald; Cummings, W. D. (Univ. of California, Los Angeles). J. Geophys. Res., 74: 897-9(Feb. 1, 1969).

If the number density and bulk velocity are the same for both electrons and protons, each species has a different temperature, and T_e/T_p is constant, then the double shock structure in the solar wind can be described by a single fluid model in which the number density is 2n, $T = (T_e + T_p)/2$, and $p = 2nkT$. Theoretical shock profiles are compared for $T_e/T_p = 1$, 5, and 10. (W.D.M.)

12493 LABORATORY SIMULATION EXPERIMENT ON SOLAR WIND INTERACTION WITH THE MOON. Kristoferson, Lars (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 74: 906-8 (Feb. 1, 1969).

The present model experiment on plasma flow about an obstacle was stimulated as a result of the Explorer 35 measurements and of the discussions on the electrodynamic properties of the Moon [Ness et al., 1967; Dessler, 1967]. The experiment was carried out to shed some light on how those electrodynamic properties affect the plasma flow. (W.D.M.)

12494 RESEARCH ON THE CONTINUUM SOLAR EMISSION BETWEEN 1950 AND 3000 A. Bonnet, R. (CNRS Aeronomie, Verrieres-le-Buisson, France). Ann. Astrophys., 31: 597-644 (Nov.-Dec. 1968). (In French).

The first limb-darkening measurements, together with the intensity of the continuum in the normal direction extending in the range 3000 to 1950 Å which can be observed only by means of balloon and rocket-borne instruments, are presented. These experimental data were obtained through photometric reduction of monochromatic pictures and spectra of the solar disk. (TSS) (auth)

12495 THEORETICAL WAVELENGTHS FOR Kα-TYPE X-RAY LINES IN THE SPECTRA OF IONIZED ATOMS (CARBON TO COPPER). House, Lewis L. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 18: Suppl. Ser. 155, 21-46(Feb. 1969).

Theoretical Hartree–Fock calculations have been used to determine wavelengths of Kα-type x-ray transitions in atoms in which a varying number of the outer, shielding electrons have been removed. The atoms treated range from carbon to copper, and for each element all stages of ionization are considered, with the exception, where applicable, of those stages containing electrons beyond the 3d shell. For the light elements, carbon to neon, the influence of term structure is taken into account. In addition to wavelengths, tables are given for configuration and term energies, dipole integrals, and relative multiplet strengths. Comparison of the theoretical wavelengths with known normal Kα x-ray lines and with observed or extrapolated lines in helium-like ions shows that the calculations are not in error by more than 5%. An adjustment of the calculations to match the few known wavelengths yields final results that can aid in further laboratory and astronomical studies of the identification of these unusual x-ray lines. (auth)

12496 THE SOLAR BALMER LINES. Elliott, Ian. Dublin, Univ. of Dublin, 1967. 179p.
Thesis.

The height and temporal variations of the kinematic properties of the solar atmosphere were studied by means of the local Doppler shifts in high-dispersion spectra of the Balmer lines. The spectra refer to quiet regions near the center of the solar disk and the fluctuations of the absorption line profiles reflect the vertical velocities of the macroscopic inhomogeneities. (TSS) (Disser. Abstr.)

Galaxies

12497 SPHERICAL HARMONIC ANALYSIS OF INTERSTELLAR POLARIZATION. Seymour, P. A. H. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc., 142: 33-43(Jan. 1969).

About 550 stars within 500 pc of the Sun were divided into five distance groups and the Stokes parameters describing the polarization of the stars were expanded in spherical harmonics for each group. From the harmonic analysis the following was deduced. The magnetic field of the Galaxy consists of regions or "clouds" over which the field is organized. The average direction of the field in each of these "clouds" is a random deviation from the general spiral arm field. The North Galactic Spur lies at a distance somewhere between 0 and 110 pc. The Local Spiral Arm field points in the direction $l = 50°$, $b = 0°$. (auth) (UK)

12498 DISSOCIATION–IONIZATION FRONTS IN INTERSTELLAR GAS CLOUDS. II. THE STRUCTURE AND PROPAGATION OF R-TYPE FRONTS. Mendis, D. A. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc., 141: 409-26 (1968).

The early phase of the development of a Strömgren sphere in an interstellar cloud of molecular hydrogen is considered. A complete analysis of the R-type dissociation–ionization fronts that occur during this phase is given and their structures are computed using a quasi-steady flow approximation. The evolutionary sequence of R-type fronts is followed using J_f, the flux reaching the front, as a time-dependent parameter. Initially a weak R-type front propagates directly into the neutral gas. The gas then experiences practically no mechanical effects. As the front slows down, mechanical effects become progressively more important and the process culminates in the appearance of a shock within the front, whereby it is converted into a strong R-type. This constitutes the end of the formation stage of the Strömgren sphere. As the front slows down further the shock moves toward the neutral end and finally emerges from it. The critical speeds for weak R-type fronts are seen to be somewhat greater in the molecular case than those in the purely atomic case. A preliminary analysis indicates that strong D-type fronts, which require rather restrictive initial conditions in the purely atomic case, are more likely to occur in the molecular case. (auth) (UK)

12499 ORIGIN OF GALAXIES. Harrison, E. R. (Univ. of Massachusetts, Amherst). Mon. Notic. Roy. Astron. Soc., 141: 397-407(1968).

Large astronomical structures such as galaxies evolve from primitive initial conditions in the early Universe. In their most general form these initial conditions consist of density, kinematic, and composition inhomogeneities, existing jointly or separately in an otherwise homogeneous Universe. Growth and damping mechanisms are considered within a cosmological framework that assumes that density and temperature both increase as one goes back in time. From various points of view—long-range interactions, coherent fluctuations, statistical fluctuations, and by invoking causality—it is argued that within the limitations of our knowledge there are persuasive reasons for thinking that the inhomogeneities were imprinted in the Universe from the earliest moment of its expansion. (auth) (UK)

12500 GALACTIC EXPERIMENTS WITH DIFFERENTIAL ROTATION. Hockney, R. W. (Stanford Univ., Calif.). Publ. Astron. Soc. Pac., 80: 662-8(Dec. 1968).

Experiments were conducted with a two-dimensional model of a galaxy, consisting of 2000 rods of mass. Varying amounts of differential rotation are given to a bar and a cylindrical galaxy. Spiral and loop structures are formed and in one case an S-shaped density wave is seen to grow from a symmetric cylinder. This wave is expected to be a long-lived feature in a real galaxy with a negligible collision rate. (auth)

12501 STUDIES OF THE LARGE MAGELLANIC CLOUD. X. PHOTOMETRY OF VARIABLE STARS. Hodge, Paul W. (Univ. of Washington, Seattle); Wright, Frances W. Astrophys. J., 17: Suppl. Ser. 153, 467-90(Jan. 1969).

Using three photoelectric sequences obtained at the Mount Stromlo Observatory, the variable stars of a section of the Large Magellanic Cloud centered at $\alpha = 5^h12^m$, $\delta = -67\overset{\circ}{.}5$ were studied. Measures in two colors, B and V, were obtained on a series of eighty ADH Schmidt plates, and measures in the blue were made on approximately four hundred Harvard Bruce plates for each variable star. Because of the long time interval of the plates, highly accurate periods of the Cepheids could be obtained, to about six significant figures in most cases. No period changes were detected that could not be attributed to data limitations. The period–luminosity relation has the form $\langle B \rangle = 18.28 - 2.80 \log P$, $\langle V \rangle = 17.82 - 3.05 \log P$, uncorrected for reddening. The slope agrees well with previous investigations if sampling problems and the probable curvature of the relation are taken into account. There is a significant zero-point difference with the results of Woolley et al., that can only be explained in terms of photometric differences. Agreement with two recent comprehensive redeterminations of the period–luminosity relation is excellent, and these lead to distance moduli for the Cloud averaging 18.90, corrected for reddening. Some differences in period–amplitude relations were found for the LMC, SMC, and our Galaxy, and these are not likely to be due wholly to selection effects. The period–color relation for LMC Cepheids agrees well with that for our Galaxy, much better than reported in previous studies. Two W Virginis variables are included, each with changing period and each subluminous for its period in comparison with the classical Cepheids. Two long-period variables, one of rather short (161 days) and one of unusually long (806 days) period, agree with the apparent period–maximum magnitude relation found for SMC long-period variables. An R CrB star with a single observed minimum of 2300 days was detected. Two β Lyrae–type eclipsing variables complete the list. A comprehensive color–magnitude diagram illustrates the relationship between all of these variable stars and the nonvariable stars of the region. (auth)

12502 STUDY OF THE NUCLEI OF SEYFERT GALAXIES. II. DESCRIPTION OF OBSERVATIONS. Souffrin, S. (Institut d'Astrophysique, Paris). Ann. Astrophys., 31: 569-78(Nov.-Dec. 1968). (In French).

A spectrophotometric study was made of 3 bright nuclei, typifying different phases of activity: NGC 1068, NGC 4151, and NGC 3516. The main features noted in the range 3100 to 8800 Å are as follows: (1) The continuous spectrum of NGC 4151 is of nonthermal origin, which explains the variations observed in comparison with other observations made by Seyfert (1943) and by Searle et al. (1964). The optical continuum of NGC 3516 on the contrary is of purely stellar origin and does not show variations with time. (2) In NGC 4151 and NGC 3516 the permitted lines have a central core and very broad wings while the forbidden lines are practically reduced to the central core, except for the [O III] 4363 line, which has an intermediate profile. (3) The fluorescent lines of O III are absent in the spectrum of NGC 1068, as Osterbrock and Parker [1965] have already noted, but they were not detected in the spectrum of NGC 4151. (4) Finally, in the spectrum of NGC 3516, variations were found in the relative intensities of the lines, in particular of the relative intensities of the Balmer lines and of [O III] 4363 lines: these are the first variations of lines observed up to now in the spectra of QSS and of other Seyfert galaxies, but it is probable that identical variations will be observed in Seyfert nuclei, in particular NGC 4151. (auth)

12503 THE HYDROMAGNETIC OSCILLATIONS AND STABILITY OF SELF-GRAVITATING MASSES. I. COMPRESSIBLE FLUID CYLINDER. Singh, Surindar; Tandon, J. N. (Univ. of Delhi). Ann. Astrophys., 31: 559-68(Nov.-Dec. 1968).

Oscillations and stability of a homogeneous compressible cylindrical gaseous mass were studied in the presence of an axial magnetic field through a variational approach. It was found that the various modes of oscillations get stabilized by a small magnetic field while a large field has a destabilizing influence. The most unstable mode is the convective mode and is unstable for $x < x^*$. The critical wavenumber associated with x^* tends to that of incompressible mode with the increase in γ. (auth)

12504 OPTICAL AND RADIO EVIDENCE OF LARGE-SCALE PECULIAR MOTIONS IN THE CAS–PER ARM. Rickard, James Joseph. College Park, Md., Univ. of Maryland, 1968. 79p.
Thesis.

Recent optical data of young open clusters, H II regions, O associations, interstellar extinction, and interstellar absorption lines together with new high-resolution 21-cm line hydrogen maps of the Cas–Per spiral arm ($97^\circ < l < 150^\circ, -1\overset{\circ}{.}0 < +1\overset{\circ}{.}0$) indicate that the interstellar medium in a large section of the arm is moving with peculiar radial velocities of the order of −20 to −30 km/sec. A distance estimate based upon the interstellar absorption lines, interstellar extinction, and H II regions indicates that the gas, dust, and ionized elements are situated 1.5 to 2.5 kpc from the Sun. A new determination of Oort's constant A shows that the extremely young clusters with H II regions form a peculiarly moving kinematic group (group P), distinct from the normally moving O associations and other young clusters (group N). The age of the group-P objects is about 6×10^6 years, while that of the group-N objects is estimated to be 10 to 30×10^6 years. The mass and gas-to-dust ratio of the Cas–Per arm are also calculated. A model which explains the observed peculiar motions and the age differences is an expanding ring or shell in the galactic plane. This ring contains about 10^7 $M_\odot$ and is expanding at 20 to 30 km/sec from the direction $l = 120^\circ$. It is approximately 1600 pc in diameter. Similar rings have been observed in the Magellanic Clouds, and are postulated to have been caused by one super-supernova, a small number of large supernovae, or a large number of ordinary supernovae. The explosion took place less than 30×10^6 years ago and the object producing the ring must have been a group N member; the peculiarly moving group P objects are much younger and were formed from the expanding ring. The high- and intermediate-velocity hydrogen clouds reported by the Dutch are also included in the model. They indicate that the explosion took place slightly above the plane. (Disser. Abstr.)

12505 COSMIC SOURCES OF INFRARED LINE EMISSION. Delmer, Thomas Nolan. San Diego, Calif., Univ. of California, 1968. 151p.
Thesis.

Three possible sources of infrared line emission are considered: planetary nebulae, the interstellar medium, and an extended nebula in Orion. In planetary nebulae, the general physical processes are considered which determine the intensities of infrared emission lines resulting from magnetic dipole transitions between fine-structure levels in certain abundant ions. Ionization equilibrium and fine-structure level population are discussed. Radiative recombination is treated in some detail where general results are given for averaged recombination Gaunt factors and for approximate intensities of helium recombination line intensities. By means of the quantum defect method, some important collision strengths for fine structure transitions are calculated. On the basis of optical data, estimates are given of the expected infrared-line intensities from nine bright planetary nebulae. There are a number of lines from these planetaries which should have intensities in the range of 10^{-18} to 10^{-16}W/cm^2 and which should be observable from below the atmosphere through the 8 to 14 and 17 to 24-μ windows. In the one case where observations are available (NGC 7027) the results of the observations are compared with the predictions. Dust is seen to be the observed continuum and may be an important source of continuum radiation in other planetaries. Improved estimates are given of the expected thermal bremsstrahlung radio emission from these nebulae, with the assumption that they are optically thin to radio radiation; comparison with radio observations indicates generally satisfactory agreement with these calculations of radio emission. The interstellar medium is described. The heating and cooling mechanisms are discussed, and it is shown that the main cooling is in line radiation which may be observable from above the atmosphere. Cosmic rays are shown to be of major importance in heating and observations could give an approximate value of the low energy flux. Some analysis is done for a gravitating sphere in the medium, and it is shown that clouds of more than 200 solar masses are the likely candidates for gravitational collapse. The dynamics of the collapse is briefly considered as a possible means of enhancing the radiation, but is not found to give a significant increase in the line radiation. The recently discovered infrared nebula in Orion is discussed and it is concluded that this is probably not a strong source of line radiation. (Disser. Abstr.)

Cosmology

Refer also to abstracts 12472 and 12499.

12506 NONSTATIC ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. II. Bera, K. (Hooghly Mohsin Coll., India); Datta, B. K. J. Phys., A (London), 1: 650-5(Nov. 1968).

The Rainich equations of the "already unified field theory" were studied in the case of nonstatic electromagnetic fields, and a solution was obtained for a space–time metric which admits a group G_4 of automorphisms. There exists a divergence-free electromagnetic field for $x^4 > 0$, except for $x^4 \to \infty$. It is shown that the electromagnetic field vanishes for large values of time, and the solution for a completely empty flat space is then obtained. (auth) (UK)

12507 NONSTATIC SPHERICALLY SYMMETRIC CHARGED DUST DISTRIBUTION IN GENERAL RELATIVITY. De, U. K. (Kalyani Univ., India). J. Phys., A (London), 1: 645-9(Nov. 1968).

Two theorems are established for a spherically symmetric charged-dust distribution. The first theorem states that the expansion (or contraction) of a spherically symmetric charged dust cannot be isotropic and the second theorem states that a static charge is unstable to perturbations, which do not destroy the spherical symmetry, and would eventually collapse. (auth) (UK)

12508 EXISTENCE OF COSMIC TIME FUNCTIONS. Hawking, S. W. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 308: 433-5(Jan. 14, 1969).

It is shown that stable causality is the necessary and sufficient condition that there should exist a cosmic time function which increases along every future-directed timelike or null curve. Stable causality means that there are no closed timelike or null curves in any Lorentz metric that is sufficiently close to the space–time metric. (auth) (UK)

12509 OBSERVATIONS IN HOMOGENEOUS MODEL UNIVERSES. Saunders, P. T. (Queen Elizabeth Coll., London). Mon. Notic. Roy. Astron. Soc., 141: 427-34(1968).

Methods are derived for the exact calculation of the luminosity distance, distance by apparent size, number counts, background radiation, and the apparent angular motion of sources in a homogeneous but anisotropic model universe. These expressions can be used in any model universe for which the first integrals of the equations of the null geodesics are known. (auth) (UK)

12510 THREE ASTROPHYSICAL PROBLEMS IN GENERAL RELATIVITY. Kaufmann III, William John. Bloomington, Ind., Indiana Univ., 1968. 67p.
Thesis.

This thesis consists of three independent problems of astrophysical interest which make extensive use of general relativity theory. The problems are polytropic spheres in general relativity, radiating spheres in the scalar–tensor theory of general relativity, and a new energy–momentum tensor and exterior solution for radiating spheres in general relativity. (W.D.M.)

12511 APPLICATION OF CONTINUOUS REPRESENTATION THEORY TO GRAVITATION-LIKE MODELS. Aslaksen, Erik Waldemar. Bethlehem, Pa., Lehigh Univ., 1968. 125p.
Thesis.

A nonlinear scalar field was studied which has one of its canonical coordinates restricted to be positive. This is of interest since the gravitational field also has certain restrictions on its canonical coordinates. To treat such a system quantum mechanically, a particular formulation of quantum mechanics called Continuous Representation Theory (CRT) is used. This theory was previously developed for systems where all coordinates were unrestricted, thus a certain extension is necessary. In particular, since the generators of the dynamical group form a different Lie algebra than the usual one, the representations of the new algebra were investigated. The CRT was then applied successively to a system with one degree of freedom, a discrete description of a field, and finally a local description of a field, all of which have the above mentioned positivity characteristics. The results of these calculations were interpreted with the help of the Weak Correspondence Principle (WCP), which states that the classical expression corresponding to a particular operator is the expectation value of the operator, or the set of diagonal matrix elements of the the operator obtained in the CRT. Thus the WCP is a generalization of the ordinary correspondence principle, and this generalization is necessary in order to treat the relation between the classical and quantum descriptions in a consistent fashion. Furthermore, the results show that the ordinary correspondence principle involves a certain approximation within the c-number formalism, in that terms of order $\hbar$ are neglected, which in a system with a finite number of degrees of freedom may at worst lead to singularities in the classical equations of motion, but in a field theory may in addition, as is well known, lead to an infinite energy term, etc. Finally, the importance of reducible representations of the algebra of the dynamical generators is brought out. It is shown that, in order to obtain a local description of the field, it is necessary to use a reducible representation. (Disser. Abstr.)

12512 STUDY OF THE INTERGALACTIC CONTINUUM AND THE COSMOGONICAL HYPOTHESES. Delpech, J.-F. (Institut d'Electronique Fondamentale, Orsay, France). Onde Elec., 48: 1113-17(Dec. 1968). (In French).

Recent experiments are described which show that the Universe as a whole behaves like a black body having a radiation temperature of 2.7°K, conforming with Dicke's theory. The author reviews the principal consequences of this fact, which is of considerable importance in connection with cosmological and cosmogonical theories. (auth)

12513 A STATIONARY AND COMPLETE, BUT UNSTABLE, INHOMOGENEOUS COSMOLOGICAL SOLUTION OF EINSTEIN'S EQUATIONS. Maitra, Samaresh Chandra. College Park, Md., Univ. of Maryland, 1968. 79p.

Thesis.

A new cosmological solution of Einstein's equation for a dust-filled universe is presented. The solution is stationary and cylindrically symmetric. The solution avoids some of the difficulties usually encountered in the dust-filled solutions of the field equations. The solution is analytic and complete and does not contain any closed time-like lines. It does not require the cosmological Λ term. However, since the solution is inhomogeneous and predicts anisotropic red shift, it cannot be taken as a model of the Universe. A number of properties of the solution are also discussed. In particular, the stability of the solution has been investigated. In investigating the stability, instead of employing the standard procedures of perturbing the metric tensor $g_{\mu\nu}$, a set of equations involving the physical quantities shear, rotation, expansion, and density have been adapted. Making some general assumptions about the perturbations, the perturbations of the metric tensor $g_{\mu\nu}$ can be uncoupled from these equations and one is left with a closed set of equations involving only physically measurable scalars. This makes it very easy to interpret the perturbations and the method is manifestly covariant. It is found that the solution is unstable for collapse along z axis and is stable under a large class of radial perturbations. Some Newtonian applications of this method are pointed out. Also in the introductory chapter some background material is given. A brief survey of the exact solutions of Einstein's field equations for dust is given and also some of the methods used to construct them are discussed. (Disser. Abstr.)

Planetary Phenomena

Refer also to abstract 12488.

12514 RESPONSE OF THE MOON TO THE TIME-VARYING INTERPLANETARY MAGNETIC FIELD. Blank, J. L.; Sill, W. R. (Bellcomm, Inc., Washington, D. C.). J. Geophys. Res., 74: 736-43(Feb. 1, 1969).

The solar-wind plasma on the sunlit side of the Moon is apparently energetic enough to confine any lunar magnetic fields within the lunar surface. Accordingly, the effect of the confining solar-wind currents is represented by imposing a surface current at the moon-solar wind boundary, and the induced magnetic field in the lunar interior is calculated as a function of frequency for a simple core–crust model. The solution provides a method for estimating the electrical conductivity, and thus for obtaining information on the temperature, of the lunar interior from magnetic field measurements at the lunar surface. (auth)

12515 SOLUTION OF RADIATIVE TRANSFER PROBLEMS IN PLANETARY ATMOSPHERES. Grant, I. P. (Atlas Computer Lab., Chilton, Eng.); Hunt, G. E. Icarus, 9: 526-34(Nov. 1968).

The numerical solution of radiative transfer problems in inhomogeneous, anisotropically scattering, plane-parallel planetary atmospheres with internal source distributions is discussed. A simple recursive method is proposed to derive the internal distribution of radiation in such an atmosphere in the manner of Grant and Hunt (1968a). A second algorithm to compute only the radiation reflected by the atmosphere is also described. Specimen numerical results for a homogeneous planetary atmosphere whose lower surface reflects radiation according to Lambert's Law are given to illustrate these methods. (auth)

12516 THE LOWER IONOSPHERE OF MARS. Aikin, A. C. (Goddard Space Flight Center, Greenbelt, Md.). Icarus, 9: 487-97(Nov. 1968).

A study was made of the ionization of the Martian atmosphere below 100 km in the context of recent data on the atmosphere and ionosphere of the planet. Suggested sources of ionization include: solar ultraviolet and x radiation, cosmic rays, meteors, radioactive material within the atmosphere, and radioactivity of the surface, the solar wind, and protons originating from solar flares. Loss processes, including charge rearrangement, dissociative recombination of ions and electrons, and negative ion formation are detailed. Possible importance of the negative ion CO_4^- is discussed. Its distribution will depend on the O_2 content of the atmosphere as well as the distribution of O and CO. CO^- and CO_3^- may be present in the ionosphere. It is shown that combination of the solar photoionization rate with that due to cosmic radiation will lead to an ion density minimum. The magnitude of the ion density and location of the minimum will depend on the atmospheric model chosen, solar activity, and solar zenith angle as well as such factors as the presence of particulate matter and meteor ionization. (auth)

12517 A SEARCH FOR JOVIAN LIMB AURORAE. Schwitters, Michael T. (Univ. of Texas, Austin). Icarus, 9: 570-3 (Nov. 1968).

High-dispersion limb spectra, with long light path through the upper atmosphere of Jupiter, were obtained using a curved slit with the coudé spectrograph of the McDonald Observatory 82-inch Struve reflector. Twenty hours of exposure yielded only one feature, in Hα, which may have been caused by Jovian auroral emission. (auth)

Atomic and Molecular Physics

Refer also to abstracts 12415, 12491, 12495, 12793, 12795, 12999, 13053, 13268, 13270, and 13519.

12518 (AECL-3194) RANGE-ENERGY DATA FOR keV IONS IN AMORPHOUS MATERIALS. Computed from the Theoretical Analysis of Lindhard, Scharff, and Schiott (1963). Winterbon, K. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1968. 37p. Dep. CFSTI. CAN $1.00.

A program has been written to compute the parameters used in Lindhard's group's analysis of stopping, viz., effective atomic number Z, screening length a, dimensionless energy ϵ, and dimensionless range ρ, for energy of 1 keV and range 1 $\mu g/cm^2$, respectively, and the electronic stopping parameter k. A table of values of these for some projectiles and targets is given. Another program calculates path length, $\rho_k(z)$, given k and ϵ. A table of path lengths for some values of k and ϵ is given. Further sets of values of these quantities can be generated easily. (auth)

12519 (GA-9062) ENERGY DEPOSITION STUDY. Annual Report, September 1, 1967-August 31, 1968. McGowan, J. William (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 30, 1968. Contract AT(04-3)-167. 35p. Dep. CFSTI.

An apparatus designed to measure the energy and angular distribution of electrons and fragment ions resulting from the collisions of fast electrons with various gases is described. Cross sections for dissociative excitation Lyman-α production of D_2 and H_2 by electrons in the energy range 10 to 80 eV are presented. The cross section for D_2 is approximately 10% less than that for H_2. Preliminary cross sections for production of Lyman-α radiation from NH_3, CH_4, and C_6H_6 by electrons up to 200 eV are shown. Results of a vaccuum ultraviolet study of dissociative excitation of N_2 by low-energy electrons are presented briefly. (A.G.W.)

12520 (NP-17742) MEASUREMENT OF Ar-Kr AND Ar*-Kr INTEGRAL CROSS SECTIONS AT INTERMEDIATE ENERGIES WITH AN ARC-HEATED AERODYNAMICALLY ACCELERATED ATOM BEAM. Report No. 68-64. Winicur, Daniel H. (California Univ., Los Angeles. Dept. of Engineering). Dec. 1968. 119p.

Relative values of the integral collision cross sections of Ar–Kr and Ar*(^{3}P)–Kr are reported as a function of relative velocity from 1.5×10^5 to 2.6×10^5 cm/sec (0.47 to 1.4 eV). These measurements were made using an arc-heated, aerodynamically accelerated argon atomic beam and a liquid-nitrogen-cooled krypton-filled scattering chamber. The velocity dependence of the Ar–Kr cross section is compared to that obtained from a semiclassical random-phase calculation based on the Kihara potential model. The potential-energy curve obtained differs from one obtained from macroscopic data in that the curve is shifted to a larger interatomic distance. The ratio of the Ar–Kr and Ar*–Kr integral cross sections is compared to the value obtained in the absence of repulsive interatomic forces. This comparison indicates that the repulsive part of the potential-energy curve is more significant for Ar*–Kr than for Ar–Kr. The electron-impact excitation cross section of argon is measured relative to the ionization cross section over the energy range from 60 to 100 eV. Upper and lower bounds on the absolute value of these cross sections are obtained. Measurements of the fractional excitation in the arc-heated beam are compared to a previously reported result and to predictions based on the assumption of equilibrium in the plasma arc. (auth)

12521 (NP-17745) MANY-PHOTON IONIZATION OF SODIUM ATOMS. Preprint No. 190. Delone, G. A.; Delone, N. B.; Donskaya, N. P.; Petrosyan, K. B. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 14p. (In Russian). Dep.

The multiphoton ionization of sodium atoms in the strong optical field ($E = 5 \times 10^6$ V/cm $\hbar\omega = 1.17$ eV) was investigated. The experimental results may be approximated by the power law $W = AF^k$. k was observed to be equal to k_0, where k_0 was the number of quanta absorbed by the electron at the process of ionization in accordance with the conservation of the energy law. In earlier experiments the multiphoton ionization of noble gases was investigated in strong electromagnetic field ($E \sim 3 \times 10^7$ V/cm). The measured value k appeared to be smaller than k_0. Apparently, the strong electromagnetic field caused the atomic energy levels to be perturbed, this effect being its result. For example in the case of 6-photon ionization of Kr atoms the perturbation could be neglected. And in accordance with the previous prediction, k proved to equal k_0. (auth)

12522 (ORNL-TM-2156) THRESHOLD ELECTRON EXCITATION AND TEMPORARY NEGATIVE ION SPECTRA OF MOLECULES. Huebner, R. H.; Compton, R. N.; Christophorou, L. G.; Reinhardt, P. W. (Oak Ridge National Lab., Tenn.). June 1968. Contract W-7405-eng-26. 125p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The scavenger technique was utilized as a method of studying low-energy electron–molecule interactions under single collision conditions in a mass spectrometer. The scope of the work included electron interactions with large polyatomic molecules, specifically the cata-condensed aromatic hydrocarbons, as well as diatomic molecules. The objectives of the investigation were: (1) to obtain the threshold electron excitation spectra of a number of molecules; (2) to observe and identify the prominent spectral features, particularly the π-triplet state of benzene and naphthalene; (3) to establish the existence of temporary negative ion resonances in benzene, naphthalene, and their derivatives; and (4) to provide new information concerning the selection rules governing electronic transitions in molecules induced by electron impact at the threshold. Threshold electron excitation spectra for nitrogen, hydrogen chloride, benzene, nitrobenzene, naphthalene, and 1-chloronaphthalene are presented and discussed. The temporary negative ion resonances discovered in benzene, naphthalene, and their derivatives are also presented. (TSS)

12523 (UCRL-18419) MEASUREMENT OF LIFETIMES BY THE PHASE-SHIFT METHOD. I. RADIATIVE LIFETIMES OF SOME EXCITED ATOMIC STATES. II. LIFETIMES OF SOME v′ REGIONS ON THE $B^3\Pi_{0^+u}$ STATE OF I_2. Cunningham, Paul T. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1968. Contract W-7405-eng-48. 92p. Dep. CFSTI.

Thesis.

The phase-shift technique has been used to measure radiative lifetimes for excited atomic states of eleven elements. Data were obtained over a large enough range of fluorescence radiance to permit evaluation of the effects of radiation entrapment and scattered exciting radiation. The following results were obtained: Al $4s^2S_{1/2}$, 7.05 nsec; Al $3d^2D$, 13.7 nsec; Ga $5s^2S_{1/2}$, 7.6 nsec; Ga $4d^2D$, 7.7 nsec; In $6s^2S_{1/2}$, 7.5 nsec; In $5d^2D_{3/2}$, 7.9 nsec; In $5d^2D_{5/2}$, 7.9 nsec; Tl $7s^2S_{1/2}$, 7.65 nsec; Tl $6d^2D_{3/2}$, 6.9 nsec; Cu $4p^2P^0$, 7.2 nsec; Ag $5p^2P^0_{1/2}$, 7.5 nsec; Ag $5p^2P^0_{3/2}$, 6.7 nsec; Na $3p^2P^0$, 16.2 nsec; Cs $7p^2P^0_{1/2}$, 114.0 nsec; Hg $6p^3P^0_1$, 115.0 nsec; Pb $7s^3P^0_1$, 6.05 nsec; and Bi $7s^4P_{1/2}$, 5.9 nsec. Estimated uncertainties range from 2% to 6%. The measured lifetimes have been converted to absorption f-values for the transitions depopulating the states studied by use of relative f-values from the literature. Lifetime measurements have been made on the B state of I_2 excited to vibrational levels around v′ ~15, 25, and 50. The lifetimes measured for v′ ~ 15 vary with the frequency of modulation of the exciting light. The results are compared with previous measurements reported in the literature and all data are interpreted in terms of a weak spontaneous predissociation of the B state. (auth)

12524 TEMPERATURE DEPENDENCE OF THE ONSET FOR NEGATIVE-ION FORMATION IN CO_2. Schulz, G. J.; Spence, D. (Yale Univ., New Haven). Phys. Rev. Lett., 22: 47-50(Jan. 13, 1969).

The formation of O^- ions with zero kinetic energy from CO_2, a reaction typical of the forms $e^- + XYZ \rightarrow X^- + YZ$ or $\rightarrow XY^- + Z$, where XYZ is a triatomic molecule was studied. The onset energy showed a marked dependence on the temperature of the gas, and it was concluded that such onset measurements must be extrapolated to 0°K to give meaningful electron affinities. (auth)

12525 FAST ALKALI NEUTRAL SOURCE. Helbing, Reinhard K. B.; Rothe, Erhard W. (General Dynamics/Convair, San Diego, Calif.). Rev. Sci. Instrum., 39: 1948-50(Dec. 1968).

The charge-exchange source described here was tested with cesium atoms in the energy range 1.5 to 500 eV. Short ion paths were used to avert the principal difficulty usually encountered in obtaining low-energy neutral beams via charge exchange—space-charge spreading of the initial ions. (M.O.W.)

12526 SPIN–LATTICE RELAXATION AND THE ANISOTROPIC PART OF THE He–H_2 INTERMOLECULAR POTENTIAL. Riehl, John W.; Kinsey, James L.; Waugh, John S.; Rugheimer, John H. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 49: 5276-81(Dec. 15, 1968).

The spin–lattice time T_1 of gaseous mixtures of H_2 and He has been measured as a function of composition and of temperature in the range 77° to 300°K at pressures such that T_1 is proportional to the density. The relationship between the experimental T_1 and cross sections for molecular reorientation of H_2 is given. From comparison of computed cross sections to the data, experimental values are obtained for parameters in an approximate form for the He–H_2 anisotropic intermolecular potential. (auth)

12527 GAUSSIAN-ORBITAL APPROXIMATION FOR THE HYDROGEN ATOM BY MINIMIZATION OF VARIANCE. Rendell, Marc; Arents, John (City Coll., New York). J. Chem. Phys., 49: 5366-8(Dec. 15, 1968).

The determination of an approximate wave function by minimization of the variance, $\int |(H-E)\psi|^2 d\tau$, is tested on the H atom. Obstacles to using other definitions of variance are discussed. Results are less favorable than those obtained by minimization of $\langle H \rangle$, but improve rapidly as n increases. (auth)

12528 SPIN–OTHER-ORBIT MATRIX ELEMENTS FOR f^3 CONFIGURATIONS. Barnes, J. A.; Carroll, B. L.; Flores, L. M. (Lockheed Electronics Co., Houston, Tex.). J. Chem. Phys., 49: 5453-8(Dec. 15, 1968).

The spin–other-orbit matrix elements for f^3 electron configurations are computed and tabulated for general usage. (auth)

12529 POSITRON ANNIHILATION IN THE NEON ISOELECTRONIC SERIES, DIAMOND AND SOLID IODINE. Klotz, A. S.; Hafemeister, D. W. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 49: 5326-30(Dec. 15, 1968).

The angular correlation of the annihilation quanta has been measured in the neon isoelectronic series (neon–neon configuration). Although the curves had different shapes, they were analyzed in terms of a single parameter Γ, the full width at half-maximum with the result: NaF[100], 9.7 ± 0.2 mrad; MgO[100], 12.1 ± 0.2 mrad; AlN (polycrystalline), 11.1 ± 0.2 mrad; and SiC (polycrystalline), 12.0 ± 0.2 mrad. The increase between NaF and MgO is attributed to the increase in the ionic charge, and the decrease for AlN and SiC is attributed to the onset of covalency. A single [100] crystal of diamond was investigated and compared with data on Si[100] and Ge[100]. There appears to be a linear relationship between Γ and r_0^{-1}, the inverse of the lattice parameter. The SiC also agreed with this trend. Finally, Γ was obtained for KI (7.1 ± 0.2 mrad) and solid iodine (9.2 ± 0.2 mrad). The relative broadening in Γ for these two compounds is consistent with Mössbauer isomer-shift data and with the known atomic configurations. Wigner–Seitz cellular-model calculations, which were performed for the positron wave function for the NaF, MgO, KI, and I_2 lattices, roughly describe several aspects of the data. (auth)

12530 PHOTON SPECTRUM FROM POSITRON ANNIHILATION IN FLIGHT. Owens, R. O.; Cardman, L. S. (Yale Univ., New Haven). Nucl. Instrum. Methods, 67: 283-7(Jan. 15, 1969).

Figures are presented which enable the target parameters of an in-flight positron annihilation system to be chosen to obtain the maximum photon yield consistent with the required photon energy spread in the annihilation spike. (auth)

12531 ANGULAR DEPENDENCE OF LOW-ENERGY ELECTRON-IMPACT EXCITATION CROSS SECTION OF THE LOWEST TRIPLET STATES OF H_2. Trajmar, S.; Cartwright, D. C.; Rice, J. K.; Brinkman, R. T.; Kuppermann, A. (California Inst. of Tech., Pasadena, Calif.). J. Chem. Phys., 49: 5464-72 (Dec. 15, 1968).

The differential cross sections for the electron-impact excitation of the lowest triplet states of molecular hydrogen (b $^3\Sigma_u^+$, a $^3\Sigma_g^+$) have been calculated from threshold to 85 eV impact energy using the Ochkur–Rudge theory. For the X $^1\Sigma_g^+ \rightarrow$ b $^3\Sigma_u^+$ transition, the relative differential cross sections were measured with a low-energy, high-resolution electron-impact spectrometer from 10° to 80° scattering angle and impact energies of 25, 35, 40, 50, and 60 eV. Theory and experiment are in good agreement for the shape of the differential cross section for energies of 35 eV and above. However, at 25 eV, the theory continues to predict a rather well-developed maximum in the cross section at around 40° while the experimental cross sections are more isotropic. An appreciable contribution to the inelastic scattering in the energy-loss region from 11 to 14 eV due to excitation to the a $^3\Sigma_g^+$ and/or c $^3\Pi_u$ states is definitely established from the observed angular distributions. A quantitative evaluation of the individual angular behavior of the excitations in this region, however, would require a resolution higher than the presently available one of 0.030 eV. (auth)

12532 PHOTOIONIZATION STUDY OF ION–MOLECULE REACTIONS IN MIXTURES OF HYDROGEN AND RARE GASES. Chupka, W. A.; Russell, Morley E. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 5426-37(Dec. 15, 1968).

The reactions producing HeH^+, NeH^+, and ArH^+ in mixtures of hydrogen with rare gases were studied by photoionization mass spectrometry. The HeH^+ and NeH^+ ions are produced by vibrationally excited H_2^+ ions; the thresholds for reaction were found to be very near the v = 3 and v = 2 states of H_2^+, respectively. Above the vibrational threshold the reaction cross section increases with vibrational quantum number and there is no evidence for a kinetic-energy threshold for these states. When accelerated to sufficient kinetic energy, H_2^+ ions in vibrational states below threshold react with a cross section that increases as the deficit in vibrational energy decreases. The rate constant for reaction of those vibrational states that are near or about the reaction threshold and that contribute most to the observed reaction becomes nearly constant at low repeller voltages. The threshold for the reaction producing HeH^+ can be made consistent with a theoretical value for the dissociation energy $D_0(HeH^+)$ = 1.835 eV. The difference $D_0(NeH^+) - D_0(HeH^+)$ is found to be 0.25 ± 0.03 eV. This yields $D_0(NeH^+)$ = 2.085 eV. In argon–hydrogen mixtures, the ArH^+ is formed by an exothermic reaction of H_2^+ in all vibrational states with Ar and also by reaction of Ar^+ ions in the $^2P_{3/2}$ ground state and (with ~30% larger cross section) of Ar^+ in the $^2P_{1/2}$ excited state with H_2. The cross section has little or no dependence on vibrational energy. Chemi-ionization processes leading to the formation of ArH^+ by excited H* and Ar* atoms were observed. The dissociation energy of ArH^+ was found to be certainly greater than 2.647 eV and, from a tentative interpretation of the chemi-ionization processes, probably greater than 3.397 eV. (auth)

12533 ELECTRON DENSITY REARRANGEMENT DESCRIPTION OF ION–MOLECULE REACTIONS. Schaffer, Jacob; Henis, J. M. S. (Monsanto Co., St. Louis). J. Chem. Phys., 49: 5377-81(Dec. 15, 1968).

A description is proposed for low-energy ion–molecule reactions of the form $A^{(\pm)} + BC \rightarrow AB^{(\pm)} + C$, which permits a prediction of the reaction cross section as either large or small. The description, restricted to reactions involving carbon, nitrogen, and oxygen (or combinations of these), is based on the idea that the probability for a reaction is determined by the nature of the change of electron density around the nuclear centers involved. The low-energy cross sections for ion–molecule reactions are predicted and found in agreement with observed values, the majority of which have been obtained or confirmed by ion cyclotron resonance techniques. (auth)

12534 MOLECULAR REORIENTATION IN COLLISIONS BETWEEN AN ATOM AND A DIATOMIC MOLECULE. Kinsey, James L.; Riehl, John W.; Waugh, John S. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 49: 5269-75(Dec. 15, 1968).

Collisions between atoms and diatomic molecules that result in reorientation of the molecular rotation relative to a laboratory-fixed frame are treated theoretically. An expression for the cross section in terms of elements of the scattering matrix is derived, and approximate numerical methods for calculation in a specific example, the low-energy scattering of H_2 by He, are discussed. (auth)

12535 H_2 LYMAN-BAND OSCILLATOR STRENGTHS. Hesser, James E.; Brooks, Neil H.; Lawrench, George M. (Princeton Univ., N. J.). J. Chem. Phys., 49: 5388-94(Dec. 15, 1968).

Absorption oscillator strengths for thirty rotational lines in nine vibrational bands of the Lyman transition, B $^1\Sigma_u^+$–X $^1\Sigma_g^+$, of H_2 have been obtained from equivalent widths measured photoelectrically under high resolution. Argon and helium continua were used in the third and first orders, respectively, of the grating. A curve-of-growth analysis of the measured equivalent widths of the Doppler-broadened lines yielded the f values. The results are in agreement with electron-scattering data obtained by Geiger and Topschowsky; consequently, there is now strong evidence from absorption f value and emission lifetime data for a significant variation of dipole transition moment with internuclear separation in the Lyman transition. (auth)

12536 LARGE MESOMOLECULES. Ponomarev, L. I.; Prokoshkin, Yu. D. (Academy of Sciences, Serphukov, USSR). Comments Nucl. Particle Phys., 2: 176-9(Nov.-Dec. 1968).

Recent experiments on the capture of slow negative mesons in hydrogenous substances that indicate that the probabilities of the meson-nucleon reactions can change by several orders of magnitude depending upon the chemical structure of the substance are discussed. These experiments are interpreted in terms of the large mesomolecule model. (C.E.S.)

12537 PROTON EXCITATION OF THE ARGON ATOM. Hurst, G. S. (Univ. of Kentucky, Lexington); Bortner, T. E.; Strickler, T. D. Phys. Rev., 178: 4-10(Feb. 5, 1969).

Studies of the excitation of argon with 4-MeV protons have been carried out by making use of a vacuum ultraviolet scanning monochromator and a 6-MeV Van de Graaff accelerator. Protons were directed through the gas and then into a Faraday cup in an arrangement in which the relative intensity of emitted light could be studied over a wide range of gas pressure (1 to 1500 torr). Four continua near 2100, 1900, 1300, and 1100 Å, respectively, as well as escape radiation originating from the 1048-Å resonance line, were studied as a function of pressure. Studies of the intensity of the four main continua (per unit of proton power dissipation) as a function of pressure led to the conclusion that each continuum has a separate atomic precursor. It is suggested that the 1300-Å continuum and the 1100-Å continuum are dissociative diatomic continua and originate from the $^1P_1$ (11.83-eV) and the $^3P_1$ (11.62-eV) resonance atomic states, respectively. It is tentatively suggested that the continua near 2100 Å and near 1900 Å are recombination spectra involving the formation of argon excimers with binding energies of about 4 eV. The 1300- and 1100-Å continua have been observed in gas discharges, but these were interpreted as a single continuum originating from the $^3P_1$ state. (auth)

12538 HYPERFINE STRUCTURE OF THE 6s6p $^1P_1$ LEVEL OF THE STABLE YTTERBIUM ISOTOPES. Budick, B.; Snir, J. (Hebrew Univ., Jerusalem). Phys. Rev., 178: 18-23(Feb. 5, 1969).

The techniques of level-crossing and anticrossing spectroscopy have been applied in a study of the hfs of the excited 6s6p $^1P_1$ level of the stable ytterbium isotopes. Details concerning the anticrossing signal, its nature, shape, intensity, and dependence on polarized light are given. The values inferred for the hfs constants are $A(^1P_1)/g_J = 206.0(16)$ Mc/sec for ^{171}Yb ($I = 1/2$) and $A(^1P_1)/g_J = 56.9(5)$ Mc/sec, $B(^1P_1)/g_J = 575(7)$ Mc/sec for ^{173}Yb ($I = 5/2$). The measured values for the $^1P_1$ level are compared with those calculated from the known hfs constants of the $^3P_1$ and $^3P_2$ levels. Fair agreement is obtained with predictions based on the modified Breit–Wills theory given by Lurio. (auth)

12539 TOWARDS AN ACCURATE WAVE FUNCTION FOR POSITRONIUM HYDRIDE. Lebeda, C. F. (Univ. of Iowa, Iowa City); Schrader, David M. Phys. Rev., 178: 24-34(Feb. 5, 1969).

A variational wave function for the ground state of positronium hydride is presented. The wave function is considerably more accurate than any previously reported. The only simplifications used are (a) only kinetic and Coulombic potential energy terms are included in the Hamiltonian, (b) the motion of the proton is ignored, and (c) the nucleus–positron distance is excluded from the wave function. The last assumption is the major source of error, but it makes possible exact evaluation of all integrals. Several trial wave functions are examined, the one giving the lowest energy being an open-shell exponential function times a 12-term power series through second-degree terms in the five remaining interparticle coordinates. Positronium hydride is found to be stable with respect to separation into hydrogen and positronium by at least 0.657 eV. The annihilation rate for two-photon events is found to be 2.095 $nsec^{-1}$ for the trial wave function giving the lowest energy, and 2.265 $nsec^{-1}$ for the trial wave function which most nearly satisfies the positron–electron cusp condition. A search for bound excited states of PsH and a bound state for the system e^+ He was unsuccessful. 88 references. (auth)

12540 VARIATIONAL CALCULATIONS OF CORRELATION EFFECTS IN LIGHT ATOMS. Jacobs, Verne (Univ. of California, Berkeley). Phys. Rev., 178: 55-69(Feb. 5, 1969).

The convergence of the "superposition of configurations" method is studied in a series of restricted calculations on the ground states of helium and lithium. A one-dimensional model with a singularity reminiscent of the cusp in the helium wave function is studied by the variational method, and the relative merits of a variety of different radial basis sets are compared. It is concluded that the basis $e^{-\alpha_n r}$ converges faster than the basis $r^{n-1}e^{-\alpha r}$ for the ground-state energies of the one-dimensional model and of helium. The two basis functions are also compared for the computed expectation values of $\Sigma_i r_i^n$, n = −2, −1, 1, 2, and $\Sigma_i \delta^3(r_i)$ in the ground state of helium, and the difference between them is observed not to be as important as for the energy. The hyperfine-splitting parameter for the ground state of lithium is found to behave so erratically that attempts to calculate it with high precision for larger systems will prove to be very difficult by this method. (auth)

12541 ELECTRON SPIN–SPIN CONTACT INTERACTION IN MANY-ELECTRON ATOMS. Fraga, Serafin; Thorhallsson, Jon (Univ. of Alberta, Edmonton). Phys. Rev., 178: 70-3(Feb. 5, 1969).

The formulation for the electron spin–spin contact interaction has been derived for p^n configurations. In addition, the radial integrals needed for the calculation of this interaction in s^n, p^n, and d^n configurations have been evaluated from existing analytical Hartree–Fock functions for all the positive ions, neutral atoms, and negative ions from He to Kr. (auth)

12542 BORN–MAYER-TYPE INTERATOMIC POTENTIAL FOR NEUTRAL GROUND-STATE ATOMS WITH Z = 2 TO Z = 105. Abrahamson, Adolf A. (City Coll., New York). Phys. Rev., 178: 76-9(Feb. 5, 1969).

Born–Mayer parameters are given, which permit, with good accuracy (to within 6%), a greatly simplified computation of a previously derived interatomic potential, U(R), based on the Thomas–Fermi–Dirac (TFD) approximation. The numerical values of A and b appearing in $U(R) = A \exp(-bR)$ are tabulated in two sets of commonly used units for 104 homonuclear pairs of neutral ground-state atoms having Z = 2 to 105. Approximate lower and upper limits of applicability, R_l and R_u, are also listed, as in the magnitude of the maximum percent error (ϵ) for each fit. R_l is generally $\sim 1.5\ a_0$ ($a_0 = 0.52917$ Å), while $R_u \sim 3.5\ a_0$. The effective upper limit probably lies at ~6 to 8 a_0. Also, with the aid of the given table and the combining rule $U_{12} \simeq (U_{11}U_{22})^{1/2}$, the interaction energies of a total of 5356 heteronuclear diatoms can readily be obtained. (auth)

12543 VARIATIONAL-BOUND METHOD FOR AUTOIONIZATION STATES. Perkins, J. F. (Army Missile Command, Redstone Arsenal, Ala.). Phys. Rev., 178: 89-92(Feb. 5, 1969).

A variational method that provides upper bounds to energies of atomic autoionization states (QHQ eigenvalues) without requiring knowledge of target eigenstates is sought. For two-electron atoms, it is found that such a method is provided by a superposition of configurations of a single set of arbitrarily chosen orbitals, with a (physically plausible) prescribed choice of secular-equation roots. This conclusion is applicable to calculations of Holøien, and explains the observed "stabilization of roots." (auth)

12544 PRODUCTS OF CHARGE EXCHANGE BY LIGHT IONS IN MOLECULAR GASES. Koopman, David W. (Univ. of Maryland, College Park). Phys. Rev., 178: 161-7(Feb. 5, 1969).

Identification has been made of the slow charged products of charge-exchange collisions of H^+, H_2^+, and He^+ with H_2, N_2, O_2, CO_2, H_2O, NH_3, and CH_4. For each target gas, molecular fragments from dissociative charge exchange predominate in reactions with He^+, while the simple nondissociated molecular ion is produced by H^+ or H_2^+ collisions. The experimental data also yield information useful in comparing the relative kinetic energies of the charged species characteristic of the various reactions studied. The results are discussed in terms of molecular energy levels and the participation of excited states. (auth)

12545 MOMENTUM-TRANSFER CROSS SECTIONS AND CONDUCTIVITY RATIOS FOR LOW-ENERGY ELECTRONS IN He, Ne, Kr, AND Xe. Hoffmann, C. R.; Skarsgard, H. M. (Univ. of Saskatchewan, Saskatoon). Phys. Rev., 178: 168-75(Feb. 5, 1969).

Conductivity ratios have been measured in weakly ionized afterglows of repetitively pulsed, electrodeless, rf discharges in helium, neon, krypton, and xenon using a microwave resonant cavity (2.7 GHz). Maxwellian electron-energy distributions were obtained at temperatures from 300 to 10,000°K, as measured with a gated microwave radiometer (4 GHz). Momentum-transfer cross sections for electrons of energy up to 2 eV in neon, krypton, and xenon were determined from the measured conductivity ratios by an iterative procedure. The results in helium support the momentum-transfer cross section determined from the electron-beam experiments of Golden and Bandel. Those for neon indicate a scattering length of +0.20 a_0. The momentum-transfer cross sections for krypton and xenon agree best with, but are generally lower than, those of Frost and Phelps and indicate a deeper (approximately 2.5 times) Ramsauer minimum. An experimental check of the theoretical electron–ion collision frequency for high-frequency, low-temperature conditions has been made. (auth)

12546 IONIZATION AND ATTACHMENT IN O_2 AND AIRLIKE N_2–O_2 MIXTURES IRRADIATED BY 1.5-MeV ELECTRONS. Hirsh, M. N.; Eisner, P. N.; Slevin, J. A. (G. C. Dewey Corp., New York). Phys. Rev., 178: 175-81(Feb. 5, 1969).

The production and removal of thermal electrons has been studied in O_2 and airlike N_2–O_2 mixtures between 1 and 10 torr during continuous and intermittent irradiation by 1.5-MeV electrons. The use of a large reaction chamber and a spatially uniform electron-beam flux reduces diffusion losses two orders of magnitude below those in previous experiments, and permits direct measurements of electron attachment at correspondingly lower total gas pressures. The observed rate coefficients for three-body attachment of thermal electrons at 300°K are $k_3(O_2) = (2.12 \pm 0.14) \times 10^{-30}$ cm^6/sec and $k_3(4N_2-O_2) = (1.10 \pm 0.07) \times 10^{-31}$ cm^6/sec, both during irradiation and in the afterglow. The effective cross sections for ionization by 1.5-MeV electrons and all resulting secondaries are $\sigma_e(O_2) = (2.83 \pm 0.7) \times 10^{-18}$ cm^2 and $\sigma_e(4N_2-O_2) = (2.45 \pm 0.7) \times 10^{-18}$ cm^2. These effective cross sections are larger than recently measured cross sections for primary ionization by a factor of 3.0 ± 0.8 in both gases. (auth)

12547 RELATIVE EXPERIMENTAL CROSS SECTIONS FOR EXCITATION OF Ba^+ IONS BY ELECTRON IMPACT (8.0 TO 98 eV). Bacon, F. M.; Hooper, J. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 178: 182-97(Feb. 5, 1969).

A crossed-beam technique has been developed for measuring the emission cross section for the excitation of electric-dipole transitions in ions by electron impact. The experimental method involves crossing modulated ion and electron beams in a well-defined collision volume. A portion of the photon flux radiated from the excited ions is detected at an angle of 90° to the plane of the two beams by direct observation of the collision volume with a photomultiplier tube. The selection of a single emission line is accomplished with an interference filter. The total flux of radiation from the collision volume for a particular transition can be determined with a knowledge of the photon detection probability of the apparatus. The possibility of an anisotropic angular distribution of radiation from the collision volume is evaluated by measuring the polarization fraction. The emission cross section can be determined from the ion- and electron-beam currents, current-density distributions and energies, and the total radiation flux. This technique has been used to measure the relative emission cross sections for excitation of the resonance transitions in Ba^+ ions by electron impact. The resonance transitions, between the excited $6^2P^0_{1/2}$ and $6^2P^0_{3/2}$ levels and the $6^2S_{1/2}$ ground state, produce photons with wavelengths of 4934 and 4554 Å. The thresholds for exciting the $6^2P^0_{1/2}$ and $6^2P^0_{3/2}$ levels are 2.5 and 2.7 eV, respectively. Over the energy range of the experiment, from 8 to 98 eV, the relative cross sections differ by approximately a factor of two, the ratio of the statistical weights of the 6P levels. The relative data also exhibit the high energy dependence predicted by the Bethe–Born approximation. From a best estimate of the photon-detection probability of the apparatus, estimated absolute cross sections are obtained, which agree remarkably well in magnitude and shape with the theoretical predictions. Checks on the data were performed to evaluate the possible effects of such parameters as the beam intensities, beam modulation frequency, ion-beam composition, ion-beam energy, electron-beam energy distribution, beam profiles, and signal-to-noise ratio. (auth)

12548 CALCULATIONS OF SPIN-EXCHANGE CROSS SECTIONS OF ALKALI ATOMS BY PARTIAL-WAVE ANALYSIS. Chang, C. K.; Walker, R. H. (Univ. of Houston, Tex.). Phys. Rev., 178: 198-204(Feb. 5, 1969).

Four different spin-dependent scattering cross sections are calculated by semiclassical and by partial-wave analyses for each of the five alkali metal atoms, Li, Na, K, Rb, and Cs, for 124 different relative kinetic energies. These cross sections are finally averaged thermally. The results agree very well with experiments. In the calculation, the interaction potential between two alkali metal atoms is calculated by individually considering the interaction due to the two valence s electrons and to the closed electronic shells of the two atoms. The two-s-electron interaction is generated ad hoc phenomenologically from the known hydrogen–hydrogen interatomic potential and the closed-shell interaction from interatomic potentials of two inert atoms corresponding to the cores. The potentials so obtained are in agreement with those constructed from band spectra. (auth)

12549 NONADIABATIC ATOMIC DISTORTION IN LOW-ENERGY ELECTRON AND POSITRON SCATTERING. Garrett, W. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., 178: 210-17(Feb. 5, 1969).

A perturbation method is used to obtain equations for the dynamic distortion of the target atom in low-energy electron and positron scattering. In an approximation adequately simple for application to heavier systems, the equations for hydrogen are reduced to a form analogous to the perturbation equations of the method of polarized orbitals. After expressing the interaction of the incident particle with an atomic electron in terms of multipole expansion, the equations are solved for the multipole components of the polarization potential, where the equations governing the distortion are dependent on the energy of the incident particle. Phase-shift results for electron and positron scattering on hydrogen are compared with adiabatic results and with results obtained by other nonadiabatic and variational methods. (auth)

12550 SCATTERING OF ELECTRONS BY C, N, O, N^+, O^+, AND O^{2+}. Henry, Ronald J. W. (Kitt Peak National Observatory, Tucson, Ariz.); Burke, P. G.; Sinfailam, A.-L. Phys. Rev., 178: 218-25(Feb. 5, 1969).

The formulation given by Smith et al., for transitions induced by electron impact among ground-state terms of atoms or ions with configurations $2p^q$ or $3p^q$, is corrected. Close-coupling equations are solved numerically for electrons incident on C, N, O, N^+, O^+, and O^{2+}. Shape resonances are found in low-energy elastic scattering by ground-state carbon and nitrogen atoms. Peaks in electron–atom inelastic cross sections are found to occur at lower energies than those calculated by Smith et al., and the magnitude of the cross sections is lower at high energies. Collision strengths for electron scattering by O^+, N^+, and O^{2+} are presented. (auth)

12551 IONIZATION OF THE ALUMINUM K SHELL BY LOW-ENERGY HYDROGEN AND HELIUM IONS. Brandt, Werner; Laubert, Roman (New York Univ., N. Y.). Phys. Rev., 178: 225-8(Feb. 5, 1969).

The yields for characteristic K-shell x rays in aluminum are measured as produced by ^1H, ^3He, and ^4He ions in the energy range 25 to 200 keV. The ionization cross sections deduced from these data are in detailed agreement with the theory, if the Coulomb deflection of the incoming particle by the target nucleus and the binding of the K-shell electrons to the incoming particle are included in the Born approximation. (auth)

12552 CHARGE-TRANSFER CROSS SECTIONS FOR NEGATIVE IONS ON ATOMIC AND MOLECULAR TARGETS. Snow, W. R.; Rundel, R. D.; Geballe, R. (Univ. of Washington, Seattle). Phys. Rev., 178: 228-34(Feb. 5, 1969).

Charge-transfer cross sections for H^- on O, O_2, and NO_2; O^- on H, O, H_2, O_2, and NO_2; and C^- on H and O have been measured over an energy range of 0.5 to 4 keV using a modulated crossed-beam apparatus. The experimental cross sections are compared with theories of resonant and nonresonant charge transfer based on a two-state approximation. For the reactions $H^- + O \rightleftharpoons O^- + H$, the cross sections are found to be consistent with detailed balancing. The effect of electron detachment of charge-transfer cross sections is discussed. (auth)

12553 SOURCE OF NEUTRAL PARTICLES. Alinovskii, N. I.; Nesterikhin, Yu. E. (Inst. of Nuclear Physics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 5, 43-6(Sept.-Oct. 1968). (In Russian).

A source of neutral particles with an energy of the order of several keV is described making it possible to obtain 3 neutral beams of H_1^0, H_2^0, and He^0. The beam currents of neutral atoms and molecules of hydrogen reaches 100 μA at a distance of ≈2 m from source. The distinctive feature of the source is the suspended charge-exchange chamber under the accelerating potential that simplifies significantly its method of supply. The results of energy and mass analyses of beams of neutral particles are presented. (tr-auth)

12554 THE ACCURACY IMPROVEMENT OF THE CORRELATION FACTOR erg/cm²R FOR LOW-ENERGY X RADIATION. Kovar, Z.; Handl, J. (Inst. of Nuclear Research, Prague). Czech. J. Phys., 18: 1390-1401(1968).

The results of calorimetric measurements of the correlation factor erg/cm² R for filtered and unfiltered x radiation in the energy region up to 220 keV are given. The value of the correlation factor for x radiation filtered by 3-mm Cu measured by a calorimeter is compared with the values of the correlation factor calculated by an independent method from the energy spectra of the same radiation. The initial spectra are obtained by means of a numerical graphical method from transmission curves measured by means of an ionization chamber in copper and tin. This comparison has shown very good agreement between the calorimetric value of the correlation factor 3.45×10^3 erg/cm² R and those calculated by using White's values of the correlation factor depending on the x radiation energy, provided the average energy required to produce an ion pair in air is 34.0 eV. The experimental results thus obtained permit evaluation of the amount of average effective energy of the measured x radiation, which is equivalent to the energy of monochromatic x radiation having the same correlation factor, in comparison with the effective energy, currently determined by ionization measurements of the half-value layers. (auth)

12555 SPECTRAL DISTRIBUTION OF ATOMIC OSCILLATOR STRENGTHS. Fano, U. (Univ. of Chicago); Cooper, J. W. Rev. Mod. Phys., 40: 441-503(July 1968).

Information on the spectrum of oscillator strength for neutral atoms in their ground states is surveyed with particular regard to recent progress in the far uv–soft x-ray range and to the theoretical interpretation of data from experiments and from numerical calculations. The analysis brings out numerous aspects of atomic mechanics and problems that remain unsolved. An effort is made to interconnect different theoretical approaches within the framework of the theory of atomic spectra. (auth)

12556 IMPROVED VALUES FOR ENERGY LEVELS, RITZ STANDARDS, AND INTERFEROMETRICALLY MEASURED WAVELENGTHS IN Th I. Valero, Francisco P. J. (Univ. Nacional, La Plata, Argentina. Consejo National de Investigaciones Cientificas y Tecnicas, La Plata, Argentina). J. Opt. Soc. Amer., 58: 1948-53(Aug. 1968).

Improved values for 18 even energy levels and 102 odd energy levels of Th I were calculated from interferometrically measured wavelengths. The wavelengths of 756 lines in the range from 3062 to 11,060 Å were calculated as Ritz standards from the values obtained for the energy levels. The accuracy of the wavelengths was tested using the combination principle and was found to be one part in 1.3×10^8 to 3.6×10^7. (auth)

12557 MOLECULAR COLLISIONS. VII. NUCLEAR SPIN AND STATISTICS EFFECTS. Biolsi, Louis; Curtiss, C. F. (Univ. of Wisconsin, Madison). J. Chem. Phys., 48: 4508-16 (May 15, 1968).

The effect of nuclear spin on the expressions for the differential and degeneracy-averaged scattering cross sections for collisions of two diatomic molecules, developed in previous papers in this series, is considered. These expressions are then reformulated in terms of another basis set of functions, making use of the diagrammatic techniques introduced earlier. Collisions between indistinguishable molecules are also considered. The resulting expressions reduce, in the limiting case of spherical molecules, to previously known results. (auth)

12558 THE HYPERFINE STRUCTURE OF POSITRONIUM AND THE DECAY RATE OF THE $^1S_0$ STATE OF POSITRONIUM. Theriot, Edward Dennis Jr. New Haven, Yale Univ., 1967. 115p.

Thesis.

Positronium, the bound state of an electron and a positron, is an ideal system for a test of quantum electrodynamics because no particles foreign to the theory are present. Furthermore, the study of positronium provides the principal test of the Bethe–Salpeter equation, which describes the bound-state two-body system. The energy separation in the ground n = 1 state between orthopositronium ($^3S_1$ state) and parapositronium ($^1S_0$ state), which is called the hyperfine structure interval, is the important quantity that was determined for positronium. The theoretical value of the hyperfine structure splitting was computed to order α^3Ry on the basis of the Bethe–Salpeter equation by Karplus and Klein to be $\Delta\nu = (\Delta W/h) = (1/2)\ \alpha^2 c\ \mathrm{Ry}_\infty\ [7/3 - \alpha/\pi\,(32/9 + 2 \ln 2)] = 2.03373 \times 10^5$ Mc/sec, where $\alpha^{-1} = 137.0388$, $c = 2.997925 \times 10^{10}$ cm/sec, and $\mathrm{Ry}_\infty = 1.0973731 \times 10^5\ \mathrm{cm}^{-1}$, all values from the 1965 compilation of Cohen and Dumond. The interval was measured previously by Deutsch, Brown, and Weinstein who obtained the value $\Delta\nu = (2.03380 \pm 0.00040) \times 10^5$ Mc/sec and by Hughes, Marder, and Wu who obtained the value $\Delta\nu = (2.03330 \pm 0.00040) \times 10^5$ Mc/sec. The present experiment reports a value of $\Delta\nu = (2.03403 \pm 0.00012) \times 10^5$ Mc/sec which represents an increase in overall accuracy by a factor of four to six parts in 10^5 (1 std. dev.). This error is comparable to that expected in the theoretical calculation due to the neglect of terms of relative order α^2 ($\alpha^2 \sim 5$ parts in 10^5) and hence a computation of the α^4Ry term is now needed. Two other quantities not previously reported were also measured in the experiment: (1) the value of the fractional pressure shift in the hyperfine structure splitting of positronium in argon gas was found to be $(1/\Delta\nu)\ (\partial\Delta\nu/\partial P) = (-0.93 \pm 0.18) \times 10^{-7}$/mm Hg or Ar; (2) A value for the parapositronium ($^1S_0$ state) decay rate determined from the natural linewidth of the resonance line was found to be $\lambda_p = (0.799 \pm 0.011) \times 10^{10}\ \mathrm{sec}^{-1}$. This agrees with the theoretical value $\lambda_p = 0.798 \times 10^{10}\ \mathrm{sec}^{-1}$ which includes the order α radiative correction. (Disser. Abstr.)

12559 ENERGY LEVELS AND CLASSIFIED LINES IN THE FIRST SPECTRUM OF TECHNETIUM (Tc I). Bozman, W. R.; Corliss, C. H.; Tech, J. L. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 72A: 559-608 (Nov.-Dec. 1968).

Progress in the classification of Tc I lines is reported. About 2200 of the known Tc I lines between 2154 and 8918 Å are now classified as transitions between 108 even and 147 odd energy levels. Tables of levels and classified lines are given. (auth)

12560 CHARACTERISTIC OXYGEN K-SHELL X-RAY PRODUCTION IN THIN FILMS OF ALUMINUM OXIDE BY 20- TO

100-keV PROTONS. Hart, Ronnie Ray. Berkeley, Calif., Univ. of California, 1967. 48p.

Thesis.

The stopping power of aluminum oxide and the oxygen K-shell x-ray production cross section for 20- to 100-keV protons were determined by measurements of the oxygen-K x-ray yield (x rays/proton) from thin films of aluminum oxide, which were formed on aluminum substrates by anodic oxidation. The stopping power data has a standard deviation of less than 10% and has maxima at proton energies of 65- and 90-keV, corresponding to peaks in the stopping powers of aluminum and oxygen. Since self-supporting thin films were not required, this technique may enable more measurements of stopping powers in the low-energy proton range. The measurements of the x-ray production cross section for the K shell of oxygen have a standard deviation of less than 7% and are consistent with previous measurements of the carbon and magnesium K-shell x-ray production cross sections. Measurements of the oxygen-K x-ray yield as a function of the oxygen surface density of the aluminum oxide targets also indicate that the experimental apparatus is capable of on-line measurements of oxygen surface densities to a sensitivity of 0.1 monolayer. (Disser. Abstr.)

12561 PHASE METHOD FOR STUDYING MOLECULAR BEAM POLARIZATION. Vasneva, G. A. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 629-32(1968). (In Russian).

The phase method was developed for studying the Stark effect in molecular beam polarization. The curves obtained for Stark balance examination of molecular distribution showed that the molecular distribution by time-of-flight in the beam determines the shape of the curve describing the signal of second resonator as a function of the magnitude of the dc electric field. (R.V.J.)

12562 DRIFT MEASUREMENTS OF ION–MOLECULE REACTIONS. Ong, P. P.; Hasted, J. B. (University Coll., London). J. Phys., B (London), 2: 91-102(Jan. 1969).

Measurements, using the drift technique of Kaneko, Megill, and Hasted (1966), are reported of rate constants for the charge-transfer processes for Ar^+ in N_2, O_2, CO, and NO in the energy range 1.0 to 15 eV, for charge transfer and dissociative charge transfer for He^+ in N_2, and for the three-body process $He^+ + 2He \rightarrow He_2^+ + He$ in the energy range 0.04 to 0.25 eV. The two-body rates are not in disagreement with flowing afterglow data. Comparison of the argon ion rates is made with "nearest resonance" calculations of Böhme, Hasted and Ong (1968). (auth) (UK)

12563 PEAKING APPROXIMATION IN SCATTERING THEORY. Kyle, H. L.; McDowell, M. R. C. (Goddard Space Flight Center, Greenbelt, Md.). J. Phys., B (London), 2: 15-19 (Jan. 1969).

A peaking approximation used by Kang and Foland (1967) to evaluate a Coulomb–Born matrix element is shown to badly misrepresent their total and differential cross sections for the 1s → 2s transition in atomic hydrogen at low impact energies. (auth) (UK)

12564 QUANTUM DEFECT THEORY. VII. ANALYSIS OF RESONANCE STRUCTURES. Seaton, M. J. (University Coll., London). J. Phys., B (London), 2: 5-12(Jan. 1969).

The scattering matrix for electron collisions with positive ions may be expressed in terms of a matrix R which varies slowly as a function of the energy. In the neighborhood of resonances, however, the scattering matrix varies rapidly. Resonances associated with a single closed channel, or with a group of degenerate closed channels, are analyzed using a method similar to that published by Gailitis in 1963. It is shown that the poles of the scattering matrix are given by a Rydberg formula containing a complex quantum defect. The case of nondegenerate closed channels is also discussed. For electron collisions with highly ionized atoms the R matrix may be calculated using perturbation theory. It is shown that, in this limit, the resonant and nonresonant contributions to excitation rates are of comparable order of magnitude. (auth) (UK)

12565 ELECTRON CAPTURE INTO THE n = 3 LEVELS OF HYDROGEN BY 10- TO 35-keV PROTONS ON GASES. Doughty, Benny Mac. Fayetteville, Ark., Univ. of Arkansas, 1968. 126p.

Absolute cross sections for electron capture into the 3s, 3p, and 3d states of hydrogen have been measured for 10 to 35 keV protons incident upon H_2, N_2, O_2, He, Ne, and Ar. Polarization measurements were made on the (3p → 2s) and (3d → 2p) radiation. Some disagreement with previous work was found in the 3s capture cross sections for protons on helium. The maximum charge transfer into the 3p state occurs in this energy range for all target gases studied. For all gases except He, the 3d cross sections decrease with increasing proton energy. The maximum 3d cross section for He occurs at about 25 keV. "Apparent" Balmer-alpha cross sections synthesized from these results compare favorably with previous values from this laboratory. The 3p capture cross sections for He agree with the measurements of de Heer et al. Disagreement was found with the shape of the Balmer-alpha excitation function as determined by Murray et al., for protons on N_2. (Disser. Abstr.)

12566 1s → ns EXCITATION CROSS SECTIONS OF H ATOMS BY FAST PROTONS. Khandelwal, G. S. (Old Dominion Coll., Norfolk, Va.). J. Phys., B (London), 2: 151-2(Jan. 1969).

An expression for the cross section for excitation of hydrogen atoms by fast protons to any state ns was obtained. Numerical values for the cross section as a function of impact energy and n are shown in tabular form. (auth) (UK)

12567 THE EXCITATION OF He^+ BY ELECTRON IMPACT. Burke, P. G. (Queen's Univ., Belfast); Taylor, A. Joanna. J. Phys., B (London), 2: 44-52(Jan. 1969).

The wave function of the $e^- - He^+$ system is expanded as a sum of close-coupling states together with a number of short-range correlation terms. The scattering matrix is evaluated in the energy range between the n = 2 and n = 3 thresholds. The convergence of the expansion of the wave function is discussed and comparison is made with recent experimental work on the 1s–2s excitation cross section. (auth) (UK)

12568 ACCURATE FIRST BORN APPROXIMATION CROSS SECTIONS FOR THE EXCITATION OF HELIUM BY FAST ELECTRONS. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London), 2: 26-44(Jan. 1969).

Accurate first Born approximation cross sections are given for the electron-impact excitation of the ground state of helium to the n ^{1}S (n = 2 to 7), n ^{1}P (n = 2 to 6), and n ^{1}D (n = 3 to 6) excited states. Many-parameter correlated wave functions for both the initial and final states was employed in the length formulation of the Born approximation integrals to obtain cross sections for excitation to the n ^{1}S (n = 2 to 7), n ^{1}P (n = 2, 3, 4), and 3 ^{1}D states. Calculations were also performed in both length and velocity formulations using a six-parameter ground-state wave function and unrestricted Hartree–Fock excited-state wave functions. The results are compared with other calculations and with experiment. (auth) (UK)

12569 INTENSITY PERTURBATIONS DUE TO CONFIGURATION INTERACTION OBSERVED IN THE ELECTRON ENERGY-LOSS SPECTRUM OF N_2. Geiger, J.; Schroeder, B. (Technischen Univ., Berlin). J. Chem. Phys., 50: 7-11(Jan. 1, 1969).

The electron energy-loss spectrum of 25-keV electrons in molecular nitrogen has been re-investigated in the 12.5 to 14.9-eV energy-loss range with improved energy resolution of 10 MeV. The band intensities of the b and b′ progressions, which consist of the bands j, b, m, p, q, and b′, g, f, r, s, t as recently turned out, exhibit strong perturbations due to configuration interaction with the c and c′ state, respectively. The disturbed intensity in the progressions is quite analogous to the one in the two-electron excitation region of helium. Intensity perturbation in the o series, if any, should be very weak. (auth)

12570 FINE STRUCTURE OF THE X-RAY K-ABSORPTION SPECTRUM OF YTTRIUM. Bhide, V. G.; Bhat, N. V. (National Physical Lab., New Delhi). J. Chem. Phys., 50: 42-6(Jan. 1, 1969).

The x-ray K-absorption spectrum of metallic yttrium has been investigated using a 400-mm bent crystal (mica) spectrograph. The extended fine structure has been explained in the light of Hayasi's theory. The bond lengths have been computed for the yttrium metal and five of its compounds using Lytle's analysis. Plasma oscillation theory seems to explain satisfactorily the first two absorption maxima close to the absorption edge. (auth)

12571 CALCULATION OF LOWER BOUNDS TO ENERGIES OF MOLECULAR SYSTEMS. I. MATHEMATICAL METHODS AND ENERGY VARIANCES FOR SIMPLE SYSTEMS. Keaveny, Ian T.; Christoffersen, Ralph E. (Univ. of Kansas, Lawrence). J. Chem. Phys., 50: 80-5(Jan. 1, 1969).

The energy variance, which provides a sensitive test for any proposed wave function, has been calculated for a series of Gaussian-type wave functions for the systems H_2^+, H_2, HeH^+, He_2^{++}, and H_3^+. The integrals that arise over the square of the Hamiltonian can be expressed either in closed form, or involving a single numerical integration. The magnitude of the values obtained for the energy variance, which should be zero for an exact solution, is consistent with other suggestions that the operator $\mathcal{H}^2$ magnifies the poor features of trial functions. Moreover, for the two-electron systems, an evaluation of the three components of $\langle \mathcal{H}^2 \rangle$, $\langle T^2 \rangle$, $\langle TV + VT \rangle$, and $\langle V^2 \rangle$, shows by their lack of convergence that they all contribute to this result. A further examination of these wave functions is made by a calculation of the net forces acting on the nuclei. (auth)

12572 DYNAMICS OF THE REACTIONS OF N_2^+ WITH CH_4 AND CD_4. Gislason, E. A.; Mahan, Bruce H.; Tsao, Chi-Wing; Werner, Arthur S. (Univ. of California, Berkeley). J. Chem. Phys., 50: 142-50(Jan. 1, 1969).

Product velocity vector distributions have been determined for the reactive and nonreactive scattering of N_2^+ by CH_4, CD_4, and Ne. In the most probable reactive events, N_2H^+ and N_2D^+ are scattered forward at almost exactly the velocity calculated from the ideal stripping model. At the higher projectile energies, the internal excitation of CH_3 even for zero-angle scattering is significant, and product internal excitation increases with increasing angle. A large isotope effect favoring abstraction of H over D was found. The nonreactive scattering showed the occurrence of highly inelastic collisions, even for small-angle scattering, and a feature that may be due to the collisional electronic excitation of CH_4 or of N_2^+ was discovered. (auth)

12573 INTRA-ATOMIC MAGNETIC INTERACTIONS IN f^n CONFIGURATIONS. I. SPIN-SPIN INTERACTION FOR f^2 AND f^3 CONFIGURATIONS. Malli, Gulzari; Saxena, K. M. S. (Simon Fraser Univ., Burnaby, British Columbia). J. Chem. Phys., 174-81(Jan. 1, 1969).

The spin–spin interaction matrix elements have been evaluated for all the states arising from f^2 and f^3 electron configurations. These matrix elements have been used to calculate the spin–spin interaction for $Ce(4f^2)$ with $Z = 58$ and $Pr(4f^3)$ with $Z = 59$ using numerical Hartree–Fock wave functions. (auth)

12574 INELASTIC TRANSITION PROBABILITIES AND THEIR ROLE IN THE QUENCHING OF GLORY EXTREMA IN ATOM–DIATOMIC SCATTERING. Olson, R. E.; Bernstein, R. B. (Univ. of Wisconsin, Madison). J. Chem. Phys., 50: 246-52(Jan. 1, 1969).

Rotational inelastic transitions in atom–diatomic collisions have been investigated via several approximation treatments. In the high-velocity limit the restricted distorted-wave approximation (RDWA) yields transition probabilities $P(j \rightarrow j')$, in agreement with the first-order sudden approximation at all impact parameters. Calculations of $P(j \rightarrow j')$ at the glory impact parameter by the RDWA (further reduced by incorporating the Born approximation) agreed well with computations by the full distorted-wave procedure (over a wide range of energies and anisotropy parameters). In the pure distorted-wave treatment no glory quenching arises due to inelastic effects; however, in higher-order approximations inelastic quenching becomes important. By the use of a renormalized distorted-wave procedure (designed to preserve the unitarity of the S matrix) an improved equation for $P(j \rightarrow j')$ is developed, leading to a quenching formula equivalent to that of Cross (based upon the high-velocity limit of his "infinite-order" distorted-wave treatment). (auth)

12575 CHARGE TRANSFER OF N_2^+, O_2^+, AND NO^+ TO SODIUM ATOMS AT THERMAL ENERGIES. Farragher, A. L.; Peden, J. A.; Fite, W. L. (Univ. of Pittsburgh). J. Chem. Phys., 50: 287-93(Jan. 1, 1969).

A steady-state flowing afterglow system has been utilized to measure the two-body rate coefficients for the charge-transfer reactions of N_2^+, O_2^+, and NO^+ to sodium atoms. The reactions of N_2^+ and O_2^+ are rapid with rate coefficients of approximately 5.8 and $6.7 \times 10^{-10}/cm^3$ sec, respectively, whereas the NO^+ reaction is found to be an order of magnitude slower. (auth)

12576 COUPLED EQUATIONS AND THE MINIMUM PRINCIPLE FOR COLLISIONS OF AN ATOM AND A DIATOMIC MOLECULE, INCLUDING REARRANGEMENTS. Miller, William H. (Univ., Freiburg i. B.). J. Chem. Phys., 407-18(Jan. 1, 1969).

The collision of an atom with a diatomic molecule is treated by a coupled-channel expansion augmented by a finite number of square-integrable basis functions. The method is, in principle, capable of essentially exact results if the total energy is less than that necessary for the existence of three free atoms and should be practical for light systems at low energies. The coupled equations that must be solved to apply the minimum principle are obtained and the direct and exchange interaction matrices are given in reduced form. The case that two, or all three, of the atoms are identical simplifies the equations, and the cross-section formulas are given for arbitrary spin of the identical nuclei. (auth)

12577 ADDITIONAL QUANTUM EFFECTS IN ATOM–ATOM SCATTERING: HIGHER-ORDER GLORY SCATTERING. Helbing, Reinhard K. B. (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 50: 493-500(Jan. 1, 1969).

In atomic scattering theory the phase shift η has often been treated as a continuous function of angular momentum l, in order to replace summation over l by integration. However, because l is quantized, additional (higher-order) forward and backward glories may occur. The effect is most pronounced in like-particle scattering, where "hard-sphere" glories show up in total cross section. General formulas are derived and applied to like particles. For comparison, exact quantum calculations are presented. A criterion for the applicability of the continuous phase approximation is derived. Construction of phase-shift curves from experimental data only is discussed. (auth)

12578 INTERATOMIC POTENTIALS FOR HELIUM AND MOLECULES OF HELIUM ISOTOPES. Beck, D. E. (Univ. of Virginia, Charlottesville). J. Chem. Phys., 50: 541-2(Jan. 1, 1969).

The binding energies of the molecules $^6He_2$, $^6He^4He$, and $^4He_2$ were calculated for five proposed interatomic potentials. The binding energies were computed by assuming a wave function of the form $\psi \sim e^{-\alpha r}/r$ for large separations and integrating Schroedinger's equation ($L = 0$) inward. The results are tabulated. The expectation value of the radius of separation for the $^6He_2$ molecule is included. (A.G.W.)

12579 CONNECTION BETWEEN THE BORN SERIES AND THE PARTIAL-WAVE EXPANSION IN THE BORN PHASE-SHIFT APPROXIMATION. Bonham, R. A. (Indiana Univ., Bloomington). J. Chem. Phys., 50: 543-4(Jan. 1, 1969).

Comparison of a modified Born series with the Born phase-shift partial-wave expansion indicates that the addition of the multiplicative factor $2^l/(l + 1)$: to the first makes it equivalent to the second. It is further suggested that the modified Born series be employed to discuss problems with nonspherical potentials. (A.G.W.)

12580 NOTES ON THREE-BODY IONIC RECOMBINATION. Flannery, M. R. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys., 50: 546-7(Jan. 1, 1969).

Several discrepancies in the data presented by various investigators for the rate at low densities of the reaction $O_2^+ + O_2^- + O_2 \rightarrow [O_4] + O_2$ are pointed out. It is also suggested that this process does not correspond to the realistic situation of oxygen ions recombining in oxygen gas. The importance of the processes $O_4^+ + O_2^- + O_2 \rightarrow [O_6] + O_2$ and $O_4^+ + O_4^- + O_2 \rightarrow [O_8] + O_2$ is considered briefly. (A.G.W.)

12581 PRODUCTION OF EXCITED HYDROGEN ATOMS BY IMPACT OF FAST ELECTRONS ON SOME SIMPLE HYDROCARBONS. Vroom, D. A.; de Heer, F. J. (FOM. Instituut voor Atoom-en Molecuulfysica, Amsterdam). J. Chem. Phys., 50: 573-9(Jan. 15, 1969).

Absolute emission cross sections have been determined for Lyman and Balmer radiation from hydrogen atoms formed in dissociative excitation of methane, methane-d_4, ethane, ethylene, and benzene by impact of electrons (0.5 to 6 keV). The excited atoms have been observed by optical detection of their fluorescence. The results are analyzed in terms of the Bethe–Born approximation. It is found that the relevant collision processes go mainly via optically forbidden transitions. An isotope effect of about 20% has been measured for the productions of excited atoms from CH_4 and CD_4, indicating the importance of superexcited states. The cross sections for formation of excited hydrogen atoms are almost the same for the different hydrocarbons and therefore seem to be rather insensitive to the number of H atoms in the molecule. (auth)

12582 PRODUCTION OF EXCITED ATOMS BY IMPACT OF FAST ELECTRONS ON MOLECULAR HYDROGEN AND DEUTERIUM. Vroom, D. A.; de Heer, F. J. (FOM. Instituut voor Atoom-en Molecuulfysica, Amsterdam). J. Chem. Phys., 50: 580-90(Jan. 15, 1969).

Absolute emission cross sections for production of atoms in the $n = 2$ to 6 excited states have been determined for dissociative excitation of molecular hydrogen and deuterium by electrons having energies in the range from 0.05 to 6 keV. The excited atoms have been observed by optical detection of their fluorescence, Lyman-α radiation in the case of $n = 2$ and Balmer-α, β, γ, and δ radiation in the case of the higher states. In general there is more than one possible molecular transition that can lead to dissociation into a particular atomic state. In the case of the $n = 2$ level, however, it has been possible with the aid of previous investigations to identify some transitions that may lead to both the 2s and 2p atomic states. For the formation of the higher excited states the systematics of the processes have been determined by means of analysis of the data in the Bethe–Born approximation. A strong isotope effect was found for the production of excited atoms from molecular hydrogen and deuterium. Approximately 20% fewer excited atoms are formed in the case of the heavier isotope. This difference arises from a competition between dissociation and other processes, in particular autoionization. (auth)

12583 INTERNAL EXCITATION IN NONREACTIVE MOLECULAR COLLISIONS: RESONANCE WIDTHS IN THE SCATTERING

OF AN ATOM BY A RIGID ROTOR. Muckerman, J. T. (Univ. of Wisconsin, Madison). J. Chem. Phys., 50: 627-31(Jan. 15, 1969).

Approximate methods are employed in an attempt to reproduce the exact dependence of the widths of subexcitation resonances upon energy and the asymmetry (coupling) parameter in the scattering of an atom by a rigid rotor. Two approximation procedures are investigated. One is based on the "distortion" approximation to the resonance energies. It is shown that, except for cases of extremely weak coupling, this approximation is quite unsatisfactory. The other procedure, an extension of the "adiabatic" approximation to the resonance energies, is computationally as simple as the first method in that it does not require the numerical differentiation of the adiabatic wave functions. Agreement with the exact widths is quite good, suggesting that the approximation should be of considerable value in predicting whether or not a given resonance might be observable. (auth)

12584 ATOMIC MULTICONFIGURATION SELF-CONSISTENT-FIELD WAVEFUNCTIONS. Sabelli, Nora; Hinze, Juergen (Univ. of Chicago). J. Chem. Phys., 50: 684-700(Jan. 15, 1969).

The ground-state ^1S wave functions of the atomic isoelectronic series with two and four electrons (Z = 1 to 8, and 3 to 8, respectively), were calculated using the MC–SCF method restricted to pair replacements. These calculations were to test and demonstrate how rapidly the configuration expansions of the MC–SCF wave functions converge. In the two-electron series, nine configurations were required to yield 97% of the correlation energy, while ten configurations accounted for 86% of the correlation energy in the four-electron series. The quality of the reported wave functions has been tested by computing the expectation values of several one- and two-electron operators. The results obtained agree in general satisfactorily (deviations of ~1%) with values computed from more complex wave functions, indicating that the compact MC–SCF functions reported are indeed of high quality. (auth)

12585 OPTICAL POTENTIALS IN MOLECULAR COLLISIONS. Micha, David A. (Univ. of California, San Diego, La Jolla). J. Chem. Phys., 50: 722-6(Jan. 15, 1969).

Inelastic transitions in molecular collisions are discussed in terms of optical (complex) potentials. Adiabatic and sudden approximations for molecular collisions are considered, as well as conditions for their validity. Numerical results obtained in an adiabatic approximation are presented for rotational and vibrational transitions in the H + H_2 system, which include a study of the real and the imaginary parts of its optical potential. The relevance of optical potentials in the description of direct molecular reactions is also briefly considered. (auth)

12586 BARE-NUCLEUS AND SCREENED-NUCLEUS PERTURBATION THEORY FOR He_2. Goodisman, Jerry (Univ. of Illinois, Urbana). J. Chem. Phys., 50: 903-14(Jan. 15, 1969).

In the bare-nucleus perturbation theory, where the full interelectronic repulsion is taken as the perturbing part of the Hamiltonian, determination of the first-order wave function for a closed-shell system reduces to a set of two-electron problems. Only in the evaluation of the energy do three-electron integrals appear. One can thus produce a correlated wave function (containing interelectronic distances explicitly) without evaluation of three-electron integrals as arise in the variational method. After a review of the necessary formulas, calculations for He_2 are presented. The convergence of the energy series is disappointing. However, the same formalism can be used when any one-electron local operator is taken as zero-order Hamiltonian. In particular, screened-nucleus calculations are presented. The zero-order Hamiltonian corresponds to noninteracting electrons moving in the field of nuclei of charge 1.5. Here, the energy through second order is as good as the best variational calculations. (auth)

12587 FINAL-STATE INTERACTIONS IN COLLISIONS OF AN ATOM AND A DIATOMIC MOLECULE. Miller, William H. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 50: 931-4(Jan. 15, 1969).

The distorted-wave Born approximation (DWBA) with a semiclassical (WKB) description of relative translational motion is used to characterize final-state interactions in the collision of an atom with a diatomic molecule. The resulting cross section is found to be the product of one factor that varies slowly with energy and another that characterizes the final-state interaction. This latter factor, containing the resonant type of energy dependence, is determined solely by the distorting potential, being independent of the interaction producing the given transition. Simple physical interpretations and useful extensions are obtained by employing the concept of time delay. (auth)

12588 SEMICLASSICAL LIMIT OF THE INELASTIC SCATTERING AMPLITUDE. Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys., 50: 1036-7(Jan. 15, 1969).

A general equivalence between classical and quantum mechanical inelastic scattering amplitudes is derived. (A.G.W.)

12589 SMALL-ANGLE SCATTERING FROM ANISOTROPIC POTENTIALS. Felton, R.; Ross, J. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 50: 1038-9(Jan. 15, 1969).

Two limitations in the previous derivation by Cross [J. Chem. Phys., 47: 3724 (1967)] of a semiclassical formula for the small-angle differential cross section for an anisotropic potential are pointed out. The first limitation is the use of an asymptotic expansion for the Bessel functions, which is valid only if $kb\,\theta' \gg m'$. The second limitation is that the method gives only a partial correspondence to classical mechanics. (A.G.W.)

12590 CROSS SECTIONS FOR ASSOCIATIVE IONIZATION OF THE n = 3 STATES OF HELIUM. Turner, Charles Hudson. Austin, Tex., Univ. of Texas, 1968. 258p.

Thesis.

A measurement of the cross sections for associative ionization of the n = 3 states of helium ($He^* + He \rightarrow He_2^+ + e$) is described. The helium is excited in the positive column of a dc glow discharge yielding a distribution of excited states, ions, and electrons. The populations of the n = 3 excited states are varied selectively by photon absorption from the 2S and 2P states and monitored by optical spectroscopy. Through associative ionization there is a correlated variation in the concentration of molecular ions in the discharge. The ion current, which effuses through a small hole in the wall of the discharge tube, is focused by means of an ion lens onto the entrance aperture of a quadrupole mass filter adjusted to monitor the molecular-ion current. The relation between the effusing ion current and the ion concentration in the discharge is given by the theory of the positive column. The cross sections for associative ionization are given directly from the absolute values of the change in population of a given excited state and the accompanying change in molecular-ion concentration. (Diss. Abstr.)

12591 IONIZATION OF Kr^+ IONS BY MEANS OF ELECTRON IMPACT. Latypov, Z. Z.; Kupriyanov, S. E. Zh. Tekh. Fiz., 38: 1070-3(June 1968). (In Russian).

Effective ionization cross sections of Kr^+ ions in electron collision processes were obtained. Single and multiple ionization and the dependence on initial excitation energy was studied. This study used crossed beams of constant intensity. The cross-section dependence on electron energy is given. It is seen that the first group of ions appears at 29 eV. It includes metastable states. The second group appears at 38 eV; it consists of highly excited long-lifetime states with excitation energies near Kr^+ ionization energy. The relative branching ratios for multiple ionizations are given for a range of electron energies (25 to 430 eV). It is shown that the single ionization cross section is more strongly dependent on the excitation level of the initial atoms than in the case of multiple ionization. (ATD)

12592 PHOTOPRODUCTION OF THE ELECTRON–POSITRON PAIR IN EXTERNAL MAGNETIC FIELD. Lysov, B. A.; Dorofeev, O. F.; Pavlova, O. S. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 46-9(1968). (In Russian).

The magnetic field influence on the photoproduction of electron–positron pairs during two photon collisions in homogeneous and constant magnetic fields was calculated, using Dirac wave functions. The results obtained showed that the magnetic field increased the cross section of pair production as compared to the photoproduction of free particles. (R.V.J.)

12593 PARAXIAL APPROXIMATION FOR DENSE ELECTRON BEAMS. Danilov, V. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 3-10(Sept.-Oct. 1968). (In Russian).

Approximation equations were obtained for a narrow (paraxial) electron beam with a space axis, generalizing the known case of intrinsic field of the beam charge. A class of beam was selected for which the problem can be reduced to ordinary differential equations. The paraxial approximation equation for the narrow electron beam trajectory in a given field with a characteristic magnitude of heterogeneities $L_* \gg a_*$ (where a_* is the characteristic width of the beam) was found previously. By using the equation of Grinberg (1948), a solution is obtainable for the case in which the beam density distribution along the L_* track is nonhomogeneous. An attempt is made here to resolve the problem, considering the beam self-field. Previously, a solution was partially achieved for the case of axially symmetric beams with rectilinear axes. (tr-auth)

12594 A METHOD FOR THE DETERMINATION OF ATOMIC SCREENING PARAMETERS. Brandus, L. (Inst. of Physics, Bucharest). J. Phys., B (London), 2: 137-44(Jan. 1969).

A new method for the determination of atomic screening parameters is considered. With the aid of this method the values of screening parameters are determined for the ground state and some excited states of He and Ne atoms. (auth) (UK)

Cosmic Radiation

Refer also to abstracts 11816 and 13078.

12595 (AECL-3051) COSMIC RAY NM-64 NEUTRON MONITOR DATA FROM KULA, HAWAII. Carmichael, H.; Steljes, J. F.; Maurin, J. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1968. 66p. Dep. CFSTI. CAN $1.50.

Uncorrected and barometer-corrected hourly data from a 3-NM-64 mobile latitude survey neutron monitor stationed at Kula, Maui, Hawaii, are given in tabular form for the period from August 1966 to December 1967. Graphs of the corrected data and of the barometric averages are given for the same period. The site is about 1000 m above sea level and the data are corrected to 68.6 cm Hg. (auth)

12596 (ORNL-tr-2099) GAMMA RADIATION IN SPACE AND IN THE ATMOSPHERE. Rocchia, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-R-2939. 74p. Dep. CFSTI.

Thesis. Submitted to Univ. of Paris, Faculty of Sciences, Orsay, France.

An abstract of the original French report appeared in NSA 20: 36095. (W.D.M.)

12597 EAST-WEST ASYMMETRY AND CHARGE SIGN RATIO OF PRIMARY COSMIC-RAY ELECTRONS AT 8.3 GV RIGIDITY CUT-OFF. Agrinier, B. (CEN, Saclay, France); Koechlin, Y.; Parlier, B.; (and others). Nuovo Cim., Lett., 1: 53-6(Jan. 1, 1969).

In order to extend to higher energies the authors' previous results at 5.4 GV on the charge-sign ratio and east-west asymmetry of the incoming flux of primary cosmic-ray electrons, four successful balloon flights of an instrument containing a small multiplate spark chamber were made, at an effective vertical cutoff of 8.3 GV, in July 1967 from Trapani-Birgi, Italy. (W.D.M.)

12598 DIFFERENTIAL ENERGY SPECTRUM OF PROTONS, HELIUM NUCLEI, AND ELECTRONS. Badhwar, G. D.; Deney, C. L.; Kaplon, M. F. (Univ. of Rochester, N. Y.). J. Geophys. Res., 74: 743-54(Feb. 1, 1969).

The differential energy spectrum of protons and helium nuclei in the energy band 60 to 1000 MeV/nucleon was measured during July 1967, using a combination of lithium-drifted silicon detectors and a scintillator-Cherenkov counter, flown from Fort Churchill, Canada, under 2.4 g/cm^2 of residual atmosphere. It is shown that the detector system had enough resolution to separate deuterons and tritons from protons in the limited energy band of 20 to 38 MeV/nucleon. The energy spectrum of 4.5- to 10-MeV electrons was determined at the flight altitude. An almost complete lack of knowledge on the re-entrant electron energy spectrum makes it very difficult to calculate the energy spectrum at the top of the atmosphere. (auth)

12599 NEUTRON PRODUCTION BY COSMIC RAYS AT EARTH'S SURFACE. Gorshkov, G. V.; Tsvetkov, O. S. At. Energ. (USSR), 26: 27-31(Jan. 1969). (In Russian).

The neutron density distribution of cosmic rays in fresh water at a depth of 0 to 0.45 m was measured at geomagnetic latitudes 56°N (at sea level), 37°N (350 m altitude above sea level), and 33°N (2150 m altitude) by means of four BF$_3$ counters (enrichment in ^{10}B to 85%). The transient maximum of the neutron density was detected at a depth of 0.045 ± 0.005 m. The transient effect damped at a depth of 0.45 m and further the neutron density decreased exponentially according to the mean free path of the neutron producing component, equal to 152 ± 9 g/cm^2 (56°N, sea level). The absolute rate of neutron production in water at sea level was found to be equal to $(3.67 \pm 0.16) \cdot 10^{-5}$ n/g,s for 56°N and $(3.0 \pm 0.2) \cdot 10^{-5}$ n/g,s for 37°N. The slow neutron fluxes were equal to $(1.67 \pm 0.08) \cdot 10^{-3}$ and $(1.37 \pm 0.09) \cdot 10^{-3}$ n/scm^2, respectively. The latitude effect at sea level between 56°N and 37°N is (18 ± 1)%. The neutron production rate in water at 2150 m altitude was found to be equal to $(14.9 \pm 0.6) \cdot 10^{-5}$ n/g,s, i.e., 4.9 times more than that at sea level and 37°N, which corresponds to $L = (155 \pm 9)$ g/cm^2, where L—mean free path of neutron producing component of cosmic rays in air. (auth)

12600 VARIATSII KOSMICHESKIKH LUCHEI I SOLNECHNAYA AKTIVNOST'. (Cosmic-Ray Variations and Solar Activity). Kuz'min, A. I. Moscow, Izdatel'stvo Nauka, 1968. 160p.

Systematized and generalized results are given on experimental studies carried out during the 1964-65 IQSY. The measurements with a unique set of instruments in Yakutsk gave information on the spectral variations of cosmic rays in a wide range of energies from 10^9 to 10^{11} eV. Descriptions of the instruments, including diagrams of the muon detectors and recorders are given in the first chapter. Anisotropic studies, mean distribution of cosmic rays and relation to geomagnetic activity, and thermodynamic characteristics of the system are discussed in the second and third chapters. The fourth chapter includes data on variations of the isotropic component of cosmic-ray distribution, considering the Forbush decreases and 27-day secular variations. The fifth and last chapter presents new concepts of the nature of cosmic-ray variations and stimulates a new approach to future studies. An appendix includes tables of vertical measurements of the muon component at 0, 7, 20, and 60 MW(e). 134 references. (R.V.J.)

12601 ASTROPHYSICS OF COSMIC RAYS. Ginzburg, Vitalii Lazarevich (Lebedev Inst. of Physics, Moscow). Priroda, No. 7, 2-12(July 1968). (In Russian).

The history of cosmic-ray studies is divided into the early work 50 years ago after their first observation, the period after the Second World War when new techniques were introduced into astrophysics, and the contemporary field of study. Various processes for their formation are noted. Descriptions of the Galaxy accounting for their existence are given, and other information relating to their nature and origin, such as the energy spectrum between 10^{10} and 10^{20} eV, is related to the present understanding. Chemical properties of cosmic rays are tabulated; the form of the energetic spectrum of the electron component, and its relation to the nature of the positron component, is discussed. Problems of x and γ astronomy for the next 5 to 15 years are proposed. (BBB)

Direct Energy Conversion

Refer also to abstracts 11686, 12992, and 13422.

12602 (CEA-CONF-1041) ALL-METAL THERMIONIC NUCLEAR MODULE. Devin, B.; Durand, J. P.; Ragot, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 8p. (In French). (CONF-680508-9). Dep.

From 2nd International Conference on Thermionic Electrical Power Generation, Stresa, Italy.

This all-metal thermionic module is distinguished from a normal cylindrical diode by the collector ensemble. The Mo collector is covered by a layer of alumina, placed inside a tube of Ti-Al, and the two are compacted together by hot isostatic compression. The base of the collector structure has a cavity for the integrated cesium reservoir. The reservoir is charged separately with cesium-impregnated graphite. The optimum dimensions of the module were calculated. Experimental results on the performance of the all-metal thermionic module are tabulated. The lower yield in comparison with conventional converters is compensated by the simplicity of fabrication from commercial components, the sturdiness, and the cost. (J.S.R.)

12603 METHOD OF CONVERTING THERMAL ENERGY DIRECTLY TO ELECTRICAL ENERGY. (to North American Aviation, Inc.). British Patent 1,141,083. Jan. 22, 1969. Priority date June 28, 1965, United States.

The method employs multicomponent fluids, one of which is conductive, combined with magnetohydrodynamic generators. The fluid kinetics are described. (M.O.W.)

12604 NON-ISOTROPICAL ELECTRODE ASSEMBLY FOR MAGNETOHYDRODYNAMIC GENERATORS. Dubois, Andre; Sadoune, Joseph (to Commissariat a l'Energie Atomique). British Patent 1,140,938. Jan. 22, 1969. Priority date Aug. 16, 1966, France.

The invention relates to nonisotropic electrode assemblies. The assembly is of the type comprising bars of ceramic material brazed onto a cooled support. The spaces between the support are filled with a continuous block of insulating plastics material. A detailed description of the assembly is given. (M.O.W.)

12605 EXPERIMENTAL STUDIES ON WATER-COOLED CHANNELS OF AN MHD GENERATOR. Ogiwara, H.; Saito, Y. (Tokyo Shibaura Electric Co., Ltd.). Denki Gakkai Zasshi, 88-7: 1263-72(July 1968). (In Japanese).

The results of an experimental study on the behavior of the generating channel with water-cooled insulating walls and water-cooled electrodes are discussed. The construction and the control system of the experimental MHD power generator are explained. The combustion gas used in the experiment was made by high-load combustion of the mixture of kerosene and seed agent with oxygen. The voltage–current characteristics due to external electric field and the voltage drop due to resistance in boundary layer on the front of the water-cooled electrode were measured. The mechanism of current discharge of the water-cooled electrode was studied; the distribution of electric potential in the generating channel at the time of power generation was analyzed by a simple method; and the effect of resistance in boundary layer due to water-cooling on the generating behavior was considered. The voltage drop at the front of the water-cooled electrode was 100 to 200 V. The maximum output was 50 kW/m^2 in the generating experiment with 11 kG of magnetic field. The increase of internal resistance of the electrode due to water cooling was not a serious problem. (NSA of Japan)

12606 MAGNETOHYDRODYNAMICS IN FRANCE: PRESENT SITUATION AND FUTURE PROSPECTS. Magnien, M. (Electricite de France, Paris); Winter, S. pp 1468-86 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966. (In French).
See CONF-661066–(Vol.3).

The present state of French studies, tests and achievements in magnetohydrodynamics is described. Problems of possible insertion of MHD conversion in the French energy program are examined and the research programs established since 1961 are discussed. A detailed description of the studies carried out both on the closed cycle and on the open cycle is included. The aim of the closed cycle is to study the transformation in which the gases are separated from the source of heat which can be either a high temperature exchanger or, in the future, a nuclear reactor. Basic research is being made on slightly ionized plasmas in thermal disequilibrium, produced by induced electrical fields. The possibility of provoking the extra ionization by exterior means such as the various types of irradiations is also being studied. An experimental plant consisting of a pulsed generator of about one megawatt thermal power which has been commissioned by the "Commissariat á l'Energie Atomique," is described. With regard to the open cycle, it can be considered that basic studies on slightly ionized plasmas are practically completed. However, studies are being carried out on inhomogeneous veins. The results obtained with regard to the closed cycle are described, and production problems, economic aspects, and future possibilities of the MHD conversion method are examined. (auth)

12607 THE PLASMA MHD POWER GENERATOR. Brogan, Thomas R. (Colorado State Univ., Fort Collins). Advan. Plasma Phys., 1: 227-330(1968).

Electrical properties of seeded MHD-generator working fluids are described. The overall design, performance, and technology of MHD generators are described. (M.O.W.)

12608 THERMODYNAMIC AND ELECTRICAL PROPERTIES OF COMBUSTION GAS AND ITS PLASMA (1st REPORT, THEORETICAL CALCULATION). Mori, Yasuo; Ohtake, Kazutomo; Yamamoto, Mitsuyoshi; Imani, Kazutake (Tokyo Inst. of Tech., Meguro). Bull. JSME (Jap. Soc. Mech. Eng.), 11: 241-52(Apr. 1968).

Thermodynamic and electrical properties, including isentropic exponent, viscosity, and thermal conductivity, of combustion gas and its plasma, containing the elements C, H, O, N, S, and K, and coke (C) are treated. The conditions of calculation used were: temperature, 0 to 4000°K; pressure, 0.2 to 8.0 atm; equivalence ratio, 0.8 to 1.5; N_2/O_2 ratio, 0 to 79/21 (air); and K_2SO_4 seeded ratio, K/C = 0.02 to 0.4. The maximum value of the adiabatic flame temperature appears at the fuel-rich side rather than at the stoichiometric ratio of fuel and O_2, and the point moves slightly to the richer side with an increase in the O_2 concentration. When the oxidant is preheated, the adiabatic flame temperature does not increase so much as expected. Wilke's equation was adopted to calculate viscosity and Brokaw's for thermal conductivity, and the Prandtl number was also calculated. At high temperatures, these values become up to 10 times as much as those at room temperature. The compounds K_2SO_4, K_2CO_3, K_2O, and KO are considered in addition to KOH, K and K as the K compounds caused by the dissociation of the seeded K salt. The results are compared with those when only KOH, K and K are considered. Only small differences appear between these two cases above 3000°K, but considerable differences can be found below 2500°K. (BBB)

12609 ELECTRICAL AND ISENTROPIC EFFICIENCY IN MHD CONVERSION DUCTS. Borgese, Domenico; Bottiglioni, Franco. Termotecnica (Milan), 22: 225-30(May 1968). (In Italian).

The definitions of the electrical efficiency η_e and the isentropic efficiency η_i in a magnetohydrodynamic conversion duct are given. The relation existing between these two efficiencies is established. The three typical cases of operation of an MHD generator are examined. The conditions under which the difference between the two values is indifferent and under which the two efficiencies are maintained distinct are determined. (tr-auth)

12610 STUDY ON REFRACTORY MATERIALS FOR THE MHD ELECTRIC POWER GENERATION. PART 2. PREPARATION AND TEST OF REFRACTORY MATERIALS AS HEAT TRANSFERRING MEDIUM IN REGENERATOR. Kato, Taizo; Amemiya, Yoshihide (Asahi Glass Co., Ltd., Japan). Asahi Garasu Kenkyu Hokoku, 18: No. 2, 101-20(Nov. 1968). (In Japanese).

Dynamic durability tests with a newly designed testing apparatus were carried out on the refractory blocks of magnesia, alumina, and zirconia. The test conditions were simulated to those of a regenerator in a MHD power plant. For the preliminary selection of the types of refractory blocks to be tested, several types of specimens were prepared and the effects of their textures and physical properties on the thermal shock and corrosion resistance were examined. The results suggested that the coarse grain type refractories of high-purity magnesia, alumina, and semi-stabilized zirconia could be applied to the dynamic test. The test blocks were prepared from grains of electrofused magnesia, hard-sintered alumina, and zirconia by high-pressure forming and high-temperature firing. The block geometry was hexagonal prism and seven cylindrical openings were perforated perpendicularly to the hexagonal face. The total area of the openings was 25% of the whole face. The testing apparatus was designed to give cyclic temperature conditions to the test blocks forming a simulative regenerator. A packed column of twenty test blocks each of which was surrounded by six trapezoid ones, was placed in the regenerator chamber and subjected to the cyclic temperature alterations between 600 and 1500°C for 15 to 40 hours. During the heating cycle, seed material and impurities from heavy oil were introduced into combustion gases of light oil. Seed material was potassium hydroxide in a methanol solution, and the impurities were sulfur dioxide and powdered vanadium pentoxide. After the durability tests, changes in shape, size, physical properties, and mineral composition of the blocks were examined with macroscopic observation, microscopy, chemical analysis, powder x-ray diffraction, and electron probe microanalysis. Magnesia blocks showed little change in their properties except for some increase in strength probably due to a progress of sintering. Alumina blocks suffered bloating by potassium penetration. Thermal fracture was observed only on zirconia blocks. Thus, it was concluded that magnesia would be the most favorable material of the three for the heat transferring medium. (NSA of Japan)

12611 ANALYSIS OF ONE-DIMENSIONAL FLOW IN THE HALL-TYPE MHD GENERATOR. Honma, Takuya. Denki Gakkai Zasshi, 88-6: 1065-72(June 1968). (In Japanese).

The local values of output density and generating efficiency, of the Hall generator and the voltage–current characteristics and the flow of working fluid in the generator with limited size, are discussed briefly. The analysis of the Hall-type generator with limited length was performed in the range of one-dimensional flow, when the flow velocity is sufficiently rapid, so its distribution in the direction perpendicular to the flow is negligible. The design theories for the linear and the discharge-type generators are discussed. The working fluid was assumed to be the perfect gas, and the effects of heat loss and friction loss were neglected. The output of the generator was not so advantageously affected by the increase of magnetic field intensity, as the localized analysis showed. The rotating component of flow velocity peculiar to the discharge-type had the effect of decreasing the output. (TSS) (NSA of Japan)

12612 LOW-VOLTAGE ARC IN THERMIONIC CONVERTERS. COMPARISON OF THE THEORY AND EXPERIMENT. Baksht, F. G.; Dyuzhev, G. A.; Korobova, I. L.; Kaplar, V. B.; Martsinovskii, A. M.; Moizhes, B. Ya.; Shakhnazarova, G. A.; Yur'ev, V. G. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 38: 1075-94(July 1968). (In Russian).

A detailed comparison is made between theory and experiment in determining the characteristics of a plasma thermionic converter. The interelectrode spacing is filled with cesium plasma; the governing diffusion equations include temperature gradients, density gradients, and potential gradients. Allowances are made for ionization and recombination in the plasma, and the boundary conditions include both electron and ion emissions at the two electrodes. The equilibrium, Maxwellization distance for the electrons is given by $L = E/\sqrt{n}$, and the effective ionization time τ_0, by $\tau_0 = [\bar{v}_e \sigma_0 (T_e)\, n_\alpha]^{-1}$, where $\sigma_0 = 1.44 \cdot 10^{-12} \exp(-3.21\ \mathrm{eV}/kT_e)$ [cm^2]. These equations are solved on a digital computer, and the result is compared with experimentally obtained data, using Langmuir probes and spectroscopy. Extensive curves are obtained for n, T_e, V, and φ versus distance x, as well as the current–voltage characteristics for the converter, including electron emission from the anode. Agreement between theory and experiment is very good. A number of anomalies were discovered during the low voltage arc operation of the converter. For example, electron–electron collisions near the cathode generated fast electrons with a lower potential drop near the cathode, compared with the first perturbation potential. (ATD)

12613 THE THEORETICAL INVESTIGATIONS OF OPEN-CYCLE MHD GENERATORS. Popyrin, L. S.; Pshenichnov, N. N.; Roshchin, A. M. Izv. Akad. Nauk SSSR, Energ. Transp., No. 5, 33-43(Sept.-Oct. 1968). (In Russian).

One of the operational stages of an MHD generator is described using a mathematical model that combines electrostatics. The model consists of two parts, one of them designated for determination of values of physical parameters of the working substance, and the other for description of the processes related to transfer and conversion of energy in the channels. The possibility of utilization is worked out according to the model. (tr-auth)

Fluid Physics

Refer also to abstracts 12788 and 12880.

12614 ELECTROCONVECTIVE INSTABILITY WITH A STABILIZING TEMPERATURE GRADIENT. I. THEORY. Turnbull, Robert J. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 2588-96(Dec. 1968).

A uniform vertical electric field produces an instability in a poorly conducting liquid subject to a vertical temperature gradient. A gradient in conductivity resulting from the temperature gradient causes free charge to accumulate in the fluid when an electric field is applied. For the cases considered, the gradient in dielectric constant can be neglected with the significant electric force being that due to the free charge. The threshold conditions for the instability are predicted using linear perturbation theory. Approximations are made which allow the equations with space-varying coefficients to be solved. The analysis shows that, for liquids with short or moderate electrical relaxation times, the electric field causes the internal gravity wave propagating downward to become unstable. (auth)

12615 ELECTROCONVECTIVE INSTABILITY WITH A STABILIZING TEMPERATURE GRADIENT. II. EXPERIMENTAL RESULTS. Turnbull, Robert J. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 2597-2603(Dec. 1968).

A uniform vertical electric field produces an instability in a poorly conducting fluid subject to a vertical temperature gradient. A previous paper presents the theory for this instability. Here measurements are made of the voltage at the threshold for instability. Since the instability occurs as an overstability, the frequency at the threshold was also measured. These experimental results support the theory. Heat-transfer measurements show a significant increase in heat flow under the influence of electric fields. (auth)

12616 INTERFACIAL RELAXATION OVERSTABILITY IN A TANGENTIAL ELECTRIC FIELD. Melcher, James R.; Schwarz, Wilfred J. Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 2604-16(Dec. 1968).

It is well known that electromechanical polarization surface waves propagate along the lines of electric field intensity imposed tangential to the interface between perfectly insulating fluids. These waves have a stiffening effect on electrohydrodynamic equilibria that is analogous to that of the Alfvén surface waves on hydromagnetic equilibria. An investigation is presented of the dynamical effects of charge relaxation on these waves. A self-consistent model represents the relaxation in terms of an Ohmic conduction process in the bulk of the fluids, with surface shears induced by the free interfacial charges placed in dynamic equilibrium by viscous stresses. The dominant effect of the charge relaxation is to produce overstability. Experiments are described where this instability appears as a spontaneous oscillation of the interface with wave numbers directed along the lines of electric field intensity. Detailed analytical results are given for liquid–gas and liquid–liquid interfaces. The field required to produce incipient instability and the propagation direction of the observed instability are satisfactorily predicted. It is found that in this liquid–vapor case, relatively simple explicit expressions can be given for the incipient instability conditions. A discussion is given of the significance of this work for the dielectrophoretic orientation of liquids in the zero-gravity environments of space. (auth)

12617 DISCHARGE STRUCTURE AND STABILITY OF A NONEQUILIBRIUM PLASMA IN A MAGNETOHYDRODYNAMIC CHANNEL. Zauderer, Bert (General Electric Co., King of Prussia, Pa.). Phys. Fluids, 11: 2577-85(Dec. 1968).

An experimental investigation was performed of the discharge structure in a nonequilibrium plasma flowing at supersonic velocities through a linear, magnetohydrodynamic channel. Optical observations showed that the luminosity of the discharge was concentrated in streamers. The streamers were transverse to the gas velocity, they originated in the entrance region of the channel, and they propagated downstream at the local gas velocity. In addition, in the channel entrance region, where the axial electron density gradient and the convective effect were at a maximum, high-luminosity gas layers were observed on the electrode walls. These observations suggested that the discharge structure is determined by the following sequence of events occurring at the electrodes in the channel entrance region: electrical ignition of the gas, convective extinguishing, and subsequent reignition. Although streamer formation is also predicted by the theory of ionization instabilities in magnetoplasmas, other characteristics of the discharge were in disagreement with the theory. A major difference was the absence in the present experiments of plasma turbulence at large Hall parameters. (auth)

12618 COMPRESSIBLE TURBULENT MAGNETOHYDRODYNAMIC BOUNDARY LAYERS. Argyropoulos, G. S.; Demetriades, S. T.; Lackner, K. (STD Research Corp., Pasadena, Calif.). Phys. Fluids, 11: 2559-66(Dec. 1968).

A closed analytical model for compressible magnetohydrodynamic boundary layers is formulated by using transport equations for the turbulent fluctuations of species mass density, velocity, and temperature, and thus avoiding a priori relations between turbulent fluxes and mean flow quantities. The equations for both the mean and the fluctuating motion are simplified according to the boundary-layer approximation, and closure of the system is achieved by the introduction of "universal turbulence structure parameters" that only relate turbulent correlations among themselves. This model accounts for convection and diffusion of turbulent fluxes as well as for the effect of turbulence suppression by applied magnetic fields. It is shown that if convection, diffusion, and electromagnetic effects were omitted in the equations of fluctuating motion, the latter would reduce to algebraic forms defining the concepts of mixing length, turbulent Prandtl number, and turbulent Schmidt number in terms of turbulence structure parameters. (auth)

12619 A TOROIDAL MHD EQUILIBRIUM WITH A SMALL ASPECT RATIO. Ohkawa, Tihiro (Gulf General Atomic Inc., San Diego, Calif.). Kakuyugo-Kenkyu, 22: No. 2, 99-115(Jan. 1969).

MHD equilibria are calculated analytically for toroidal configurations with a small aspect ratio. The existence of configurations with a deep magnetic well and a large shear is demonstrated. (NSA of Japan)

12620 FLUID MECHANICS OF MAGNETICALLY BALANCED ARCS IN CROSS-FLOWS. Kuethe, Arnold M. (Univ. of Michigan, Ann Arbor). pp 83-9 of Developments in Mechanics. Vol. 4. Cermak, J. E.; Goodman, J. R. (eds.). Fort Collins, Colo., Midwestern Mechanics Conference, 1968.

From 10th Midwestern Mechanics Conference, Fort Collins, Colo. See CONF-670845.

Since a range of operating conditions (in the supersonic measurements) exists over which L_c (Lorentz convection parameter) is the only similarity parameter, it is concluded that the steady magnetically balanced arc may be treated as a central core with relatively uniform properties, and thus that the transfer of mass, momentum, and energy to the external flow takes place through a boundary layer. The boundary layer will be thin at high values of the Lorentz parameter and, an additional effect tending toward thinning at least the temperature boundary layer stems from the Joule heating term. For instance, at the point of maximum temperature, the value of $-\nabla^2\theta$ ($\theta = T/T_1$, where T_1 is a characteristic temperature) will be proportional to the Joule heating; thus, the greater the Joule heating the thinner will be the inner portion of the temperature layer. Since the Lorentz parameter is related to the fluid-mechanical structure of the arc, it is concluded that the conservation equations for flow of a conducting fluid under equilibrium conditions with negligible Hall effects and radiation are valid to a first approximation over the range of operating conditions covered by the subsonic and supersonic experiments. (auth)

12621 STABILITY OF A REVOLVING CONDUCTING FLUID IN A CIRCULAR MAGNETIC FIELD. Pao, Hsien Ping (Catholic Univ. of America, Washington, D. C.). pp 1449-66 of Developments in Mechanics. Vol. 4. Cermak, J. E.; Goodman, J. R. (eds.). Fort Collins, Colo., Midwestern Mechanics Conference, 1968.

From 10th Midwestern Mechanics Conference, Fort Collins, Colo. See CONF-670845.

Sufficient conditions for the stability of a revolving viscous conducting fluid in a circular magnetic field are established by a mathematical proof. Detailed results for small spacing between the cylinders are discussed. A conjugate relationship between the different branches of the critical Taylor number is discovered, and some analytical formulas for the critical Taylor number and the associated wave number are derived. A rather striking phenomenon is that there is a case in which the unstable circulatory flow field is counterbalanced by the unstable circular magnetic field such that the combined field makes a stable flow. The dual roles of viscosity and magnetic diffusivity and their physical mechanism are discussed. A clarification is made toward a better understanding of the role of the magnetic diffusivity on the effect of stabilization and destabilization. (auth)

12622 UNIQUENESS THEOREM FOR MAGNETOHYDRODYNAMIC DUCT FLOWS. Hunt, J. C. R. (Cornell Univ., Ithaca, N. Y.). Proc. Cambridge Phil. Soc., 65: 319-27(Jan. 1969).

An analysis is given of the steady, fully developed, laminar flows of uniform, electrically conducting, incompressible fluids along arbitrarily shaped ducts of constant cross section under the action of transverse magnetic fields to show that these flows are uniquely specified by certain parameters, namely: either the pressure drop along the duct per unit length or the volume flow rate and either the electric current leaving the walls of the duct at each point where the duct is connected to an external electrical circuit or the electrical potential at these points. The most important feature of the analysis is the proof that no secondary flow can exist in these fully developed flows. The analysis includes the special cases where the walls of the duct are nonconducting, and where the fluid is nonconducting (e.g., Poiseuille flow); in the latter case the uniqueness of the flow has not previously been demonstrated, as far as is known. (auth) (UK)

12623 STABILITY OF LAMINAR MAGNETOFLUID FLOW ALONG A PARALLEL MAGNETIC FIELD. Kent, A. (Culham Lab., Abingdon, Eng.). J. Plasma Phys., 2: 543-56(Dec. 1968).

A perfect magnetofluid model is used, without viscosity or resistivity. The simpler velocity and magnetic profiles are classified into stable and unstable groups. The analysis takes account of exponential and non-exponential time dependence, and of rigid and free boundaries. A variety of stability criteria are established, and related to similar results in non-conducting fluid mechanics. A constant magnetic field is shown to stabilize some velocity profiles but destabilize others. (auth)

12624 STEADY MAGNETOGASDYNAMIC FLOW PAST A POINT SOURCE. Bazer, J.; Yen, David H. Y. (New York Univ., N. Y.). SIAM (Soc. Ind. Appl. Math.) J. Appl. Math., 16: 808-33(July 1968).

Steady, nondissipative, 3-dimensional magnetogasdynamic flow past a fixed perturbing point source is studied. The governing equations are the linearized Lundquist equations. It is assumed that the free stream density, velocity, and magnetic field are constant, that the flow is fast-hyperbolic, and that the applied magnetic field is perpendicular to the free stream velocity field. The problem is determination of the disturbance field, generated by arbitrary mass, momentum and magnetic point sources. The field is a fundamental solution of the system and may be used to represent the disturbance field due to bodies immersed in the medium. An envelope of spherical waves is generated by the sources and carried downstream. It consists of 5 distinct components: an outer mantle enveloping the fast spherical wave fronts, two slow cones enveloping the slow cusped wave fronts, and two degenerate Alfvén cones. At points not on the fast, slow, and Alfvén cones, the field quantities are perfectly regular and can be realized in terms of explicit functions of the zeros of a determinantal expression. No excitation is present outside the fast or inside the slow cones. The Alfvén lines serve as supports of delta function singularities. The fundamental solution may be expressed as a superposition of fast, slow, and Alfvén modes which interfere destructively outside the fast cones and also within the slow cones. The delta function singularities represent the most singular parts of the Alfvén modes. The formulas for the fields near the wave fronts follow immediately from spherical mean representations for the fundamental solution of linear, homogeneous, symmetric-hyperbolic systems with constant coefficients in two or more dimensions. The assumption that the free stream magnetic field is perpendicular to the free stream velocity is not essential to the success of the method. (BBB)

12625 THE SOLUTION OF A MHD PROBLEM USING A NUMERICAL METHOD DEVISED BY RAETZ. Lewis, E. (University Coll., London). Quart. J. Mech. Appl. Math., 21: 401-11 (Nov. 1968).

The problem considered is that of solving the boundary layer equations for the uniform motion of a semi-infinite flat plate through an incompressible conducting fluid at rest, and subject to a constant transverse magnetic field. The solution of this problem is dependent upon a parameter M^2x/R and has been derived previously in only those regions where $M^2x/R \ll 1$ or $M^2x/R \gg 1$. For the region in which $M^2x/R \ll 1$ the solution was derived by Rossow (NACA Tech. Rep. 1358(1958)), while for $M^2x/R \gg 1$ the solution can be obtained analytically. However, using an explicit finite-difference method devised by Raetz (NAI Rep. 58−73 (1957)) for solving the three-dimensional boundary layer equations in steady compressible flow, this problem can be solved for the complete range of M^2x/R. Shortly after obtaining the solution described in this paper, Maw (Thesis, Bristol Univ., (1966)) also solved this problem numerically for the complete range of M^2x/R. The two solutions are in excellent agreement with each other, as they are also with Rossow's solution for $M^2x/R \ll 1$ and the analytic solution for $M^2x/R \gg 1$. (auth) (UK)

12626 ON THE CONDUCTING FLUID FLOW INDUCED BY A ROTATION OF A DISC IN THE PRESENCE OF A STRONG AXIAL MAGNETIC FIELD. Gorbachev, L. P.; Potanin, E. P. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 152-4(1968). (In Russian).

Stationary, viscous, incompressible, conducting fluid flow induced by rotation of a disk in a strong magnetic field was studied considering that the radius of the disk is infinite and the flow is not confined by a vessel. (R.V.J.)

12627 ON THE NON-STATIONARY CONDUCTING FLUID FLOW INDUCED BY A SLOW ROTATION OF A DISC IN A CASING IN THE PRESENCE OF AN AXIAL MAGNETIC FIELD. Gorbachev, L. P.; Grigorev, M. M. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 150-2(1968). (In Russian).

Unsteady viscous fluid flow with finite electric conductivity produced by a dielectric disk rotating in a conducting casing was studied. A finite radius disk suddenly changing from a steady state perceived a constant angular rotational velocity. The external homogeneous field was assumed to be distributed along the symmetry axis. Mathematical calculations did not take into account the thickness of the disk or the gap between the disk and the sides of the vessel. (R.V.J.)

12628 ON THE MHD CHANNEL RUNNING REGIMES. Karasev, B. G.; Lavrentev, I. V. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 148-50(1968). (In Russian).

A mathematical analysis was made of operations in an MHD channel, assuming the following factors are known: electrode voltage, channel hydraulic force, load, and magnetic field induction. (R.V.J.)

12629 MAGNETO-GASDYNAMICS OF RE-ENTRY PHENOMENA. Cambel, Ali Bulent (Research Inst. for Defense Analyses, Arlington, Va.). pp 15-52 of Developments in Mechanics. Vol. 4. Cermak, J. E.; Goodman, J. R. (eds.). Fort Collins, Colo., Midwestern Mechanics Conference, 1968.

From 10th Midwestern Mechanics Conference, Fort Collins, Colo. See CONF-670845.

The electromagnetic drag experienced by natural planetary objects presents a variety of interesting observations. Recent developments in superconducting magnet design suggest that man-made space vehicles might profit from the incorporation of an on-board magnet. A number of analytical and experimental studies are dealt with. The simulation of actual re-entry phenomena in the laboratory is discussed. Existing theoretical analyses are compared and relatively new theories are presented. Finally laboratory observations concerning shock standoff, drag, and heat transfer are presented. (auth)

12630 TURBULENT MHD FLOW IN A TRANSVERSE MAGNETIC FIELD. Ginzburg, I. P.; Skurin, L. I. (Leningrad State Univ.). Heat Transfer - Sov. Res., 1: 60-6(Jan 1969).

The motion of a turbulent stream of an incompressible fluid with constant conductivity, between two parallel smooth plates, in a transverse magnetic field, for a magnetic Reynolds number is considered. The direct effect of the magnetic field on the turbulent velocity pulsations is neglected as compared to the Hartman effect and the two-layer system of the semi-empirical turbulence theory is assumed to be valid. (auth)

12631 MHD FLOW IN PIPES WITH SUDDEN EXPANSION. Vasilev, A. S. Magn. Girdrodin., Akad. Nauk Lat. SSR, No. 2, 147-8(1968). (In Russian).

The effect of a transverse magnetic field on mercury flow in tubes with one-side or two-side sudden expansion was investigated. An attempt was made of determining the function f(n) in the range $1.67 \le \omega \le 7.5$. Graphical data are given on the variation of local resistance and pressure in the tube with $\omega = 2.5$. Theoretical and experimental data on resistance coefficient for a tube with $\omega = 2.5$, tube with one side expansion $\omega = 4$, and two-side expansion $\omega = 4$ were correlated. (R.V.J.)

12632 CALCULATIONS OF MHD FLOW IN A CHANNEL WITH FINITE OR SEMI-FINITE ELECTRODES. Kozyrenko, V. E. Magn. Gidrodin., Akad. Nauk Lat. SSR, No. 2, 144-6(1968). (In Russian).

A theory developed by V. E. Kozyrenko (Magnitnaya Gidrodinamika, No. 2, 50, 1967) was used for calculating a simple case of gas flow in a two-dimensional channel with applied magnetic field constant along the flow and with a small Reynolds number. A case of subsonic infinite flow of nonviscous, nonconducting stationary, two-dimensional gas flow was analyzed and it is shown that the assumptions of constant magnetic field along the flow is unimportant and the calculations can be applied to a general case. (R.V.J.)

12633 NONEQUILIBRIUM THERMODYNAMICS OF FLUID-FIELD SYSTEMS. Williams, Ralph Anthony. Pittsburgh, Carnegie-Mellon Univ., 1968. 142p.

Thesis.

Nonequilibrium thermodynamics is applied to the study of multicomponent, compressible, electrically and magnetically polarizable fluids, with chemical reactions, in the nonrelativistic approximation. The expressions for momentum flow and the total stress tensor are derived—not assumed. The ambiguity in the meaning of "pressure" is resolved, and a physically clear equilibrium thermodynamic system is defined and developed. The "body force" and "entropy generation" are derived. Onsager's relations are applied to a special case including the usual thermomagnetic and galvanomagnetic effects. The closed form analytical expression for the tensor relationship between "forces" and "fluxes" is derived valid for all orders of magnetic field. (Disser. Abstr.)

12634 VISCOUS MGD CHANNEL FLOW IN BOUNDARY-LAYER APPROXIMATION WITH HEAT CONDUCTION. Cap, F.; Floriani, D. (Univ. of Innsbruck, Austria). Nucl. Fusion, 8: 360-2(Dec. 1968).

Solutions which include all dissipative effects are presented for the magnetogasdynamic equations. All transport coefficients are assumed to be constant, but this is caused by the use of similarity transformation. (M.O.W.)

12635 LINEAR APPROXIMATION OF A CHANNEL FLOW OF CONDUCTING GAS WITH LARGE MAGNETIC REYNOLDS NUMBER. Korsun, A. G. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 26-31(Sept.-Oct. 1968). (In Russian).

Stationary two-dimensional flow of electrically conducting, viscous, thermally nonconductive gas in a channel with variable cross section acted upon by a transverse magnetic field was studied. At large magnetic Reynolds numbers the flow consists of the center flow and current layers on electrodes and on the nonconducting channel walls. The flow parameters were found analytically by linear approximation. The Joule dissipations in current layers were more intense than in the center flow. With the increase of Hall parameters the increment of longitudinal current and Joule dissipation also increased. (tr-auth)

12636 EXPERIMENTAL STUDIES IN MAGNETOFLUID-DYNAMICS: FLOW OVER A SPHERE WITH A CYLINDRICAL AFTERBODY. Maxworthy, T. (Univ. of Southern California, Los Angeles). J. Fluid Mech., 35: 411-16(Feb. 3, 1969).

The measured pressure distributions over the front hemisphere of a hemisphere-cylinder combination placed in an aligned-field magnetofluiddynamic flow are presented. Integration of the pressure profiles show that the form or pressure drag of the composite body first increases as the magnetic field strength increases, at a fixed flow velocity, but then decreases as the magnetic field becomes still stronger. (auth) (UK)

Geophysics

Refer also to abstract 13000.

12637 (N-68-27682) ELECTRON, ION, AND NEUTRAL TEMPERATURES AT THE MAGNETIC EQUATOR. McClure, J. P.; Farloy, D. T. Jr.; Sterling, D. L.; Van Zandt, T. E. (Jicamarca Radar Observatory, Lima (Peru)). [1967]. 11p. (CONF-670453-1). CFSTI.

From Conference on Thomson Scattering, Urbana, Ill.

12638 (N-68-27683) INCOHERENT BACKSCATTER OBSERVATIONS OF THE F REGION DURING THE NOVEMBER 12, 1966 SOLAR ECLIPSE. Peterson, V. L.; Farley, D. T.; Green, J. L.; McClure, J. P.; Sterling, D. L.; (and others) (Jicamarca Radar Observatory, Lima (Peru)). [1967]. 3p. (CONF-670453-2). CFSTI.

From Conference on Thomson Scattering, Urbana, Ill.

Electron concentrations and temperatures were measured at heights of 150 to 750 km and 150 to 550 km, respectively, at the Jicamarca Radar Observatory; and measurements were made continuously with a 25-km height resolution to obtain incoherent backscatter observations of the F region during the November 12, 1966 solar eclipse. Preliminary analysis indicates that electron temperature behavior is consistent with the theory of electron heating by elastic collisions with fast photoelectrons and cooling by collisions with ions and neutral particles. Electron temperatures indicate that the neutral temperature decreased by about 100°K during the eclipse. (STAR)

12639 (SIT-3785-8) TRANSVERSE WAVE PROPAGATION AND INSTABILITIES WITHIN THE MAGNETOSPHERE. Bird, H. H.; Schmidt, G. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Oct. 1968. Contract AT(30-1)-3785. 27p. (SIT-229). Dep. CFSTI.

The growth rates are obtained for an isotropic loss-cone velocity distribution of electrons and ions (protons) for transverse waves propagating parallel to the magnetic field. A double-humped, isotropic loss-cone velocity distribution such as is observed in the magnetosphere is considered. The thermal component is considered as effectively cold, and the interaction of waves with an energetic component whose distribution function is of the form $(a^2 + (v - V)^2)^{-n}$ is studied with a view to determining under what conditions, if any, new instability can arise. The observed distribution of the magnetosphere is considered, and numerical computations of the damping rates are presented for several L values. The calculations are restricted to waves propagating parallel to the magnetic field. (M.O.W.)

12640 DESIGN OF UNATTENDED STATIONS FOR RECORDING GEOMAGNETIC MICROPULSATION SIGNALS. Lamden, R. J. (United Kingdom Atomic Energy Authority, Blacknest, Eng.). J. Phys., E (London), 2: 125-30(Feb. 1969).

The design concepts and operational details of an unattended magnetic observatory are described. The use of Earth potential systems, and several types of magnetometer, are discussed. The recording and timing system is described, and it is shown how the correct choice of this affects the ease of visual examination. (auth) (UK)

12641 IONOSPHERIC DRIFT MEASUREMENTS ON ADJACENT AERIAL ARRAYS. Beynon, W. J. G.; Wright, J. C. (University Coll. of Wales, Aberystwyth). J. Atmos. Terrest. Phys., 31: 119-33(Jan. 1969).

Apparent discrepancies in ionospheric drift measurements made on two adjacent aerial arrays at Halley Bay during the IQSY are discussed. It is shown that the anomalies could be explained in terms of curvature in the pattern of maximum amplitude contours at the receivers. (auth) (UK)

12642 SOLAR CYCLE DEPENDENCE OF WINDS IN THE LOWER IONOSPHERE. Sprenger, K.; Schminder, R. (Heinrich-Hertz-Instituts fuer Solar-Terrestrische Physik, Berlin). J. Atmos. Terrest. Phys., 31: 217-21(Jan. 1969).

Winds at heights of about 95 km were deduced from observations of the fading of lf radio waves during the past 12 yr. Systematic changes in the "steady" and the "12-hourly periodic" components are described. (auth) (UK)

12643 CHANGES IN THE TOTAL ELECTRON CONTENT AND SLAB THICKNESS OF THE IONOSPHERE DURING A MAGNETIC STORM IN JUNE 1965. Taylor, G. N.; Earnshaw, R. D. S. (Royal Radar Establishment, Malvern, Eng.). J. Atmos. Terrest. Phys., 31: 211-16(Jan. 1969).

Measurements of Faraday rotation in geostationary satellite beacon signals, and of f_0F2 from the ground, were used to measure the changes of ionospheric total electron content and slab thickness of Jodrell Bank (53.2°N, 2.3°W) during the magnetic storm which started on June 15, 1965. Important differences from the changes observed at the same time by the same technique in the Southern hemisphere by Titheridge and Andrews (1967) were found. (auth) (UK)

12644 F-REGION EQUATORIAL IRREGULARITY BELT AS OBSERVED FROM SCINTILLATION OF SATELLITE TRANSMISSIONS. Sinclair, J.; Kelleher, R. F. (University Coll., Nairobi, Kenya). J. Atmos. Terrest. Phys., 31: 201-6(Jan. 1969).

Scintillation occurrence studies were made on 40/41 MHz recordings of satellites BE-B and BE-C at Addis Ababa, Nairobi, and Dar-es-Salaam. The results are presented in the form of latitude plots for the different seasons, each divided into pre- and post-midnight periods, and quiet and disturbed conditions.

The equatorial irregularity belt was found to vary in shape and extent. The existence of north–south elongated patches was indicated. (auth) (UK)

12645 WHISTLER-MODE PROPAGATION IN THE PRESENCE OF A LONGITUDINAL ELECTROSTATIC FIELD. Stenflo, L. (Inst. of Physics, Uppsala). J. Atmos. Terrest. Phys., 31: 197-200(Jan. 1969).

A dispersion relation for the whistler-mode propagation in a homogeneous plasma, situated in parallel constant electric and magnetic fields, was derived. Collisions were considered by means of a Fokker–Planck model. It is shown that the amplification found in a previous study is not possible because of the collisional damping. (auth) (UK)

12646 DISCUSSION ON THEORIES OF MOVEMENT OF IONOSPHERIC IRREGULARITIES. Kato, Susumu; Matsushita, Sadami (High Altitude Observatory, Boulder, Colo.). J. Atmos. Terrest. Phys., 31: 193-6(Jan. 1969).

An answer appears to be given to the question as to whether there are any serious discrepancies in the velocity of irregularities as between Kato's theory and that of Tsedilina's (1965). It is found that both theories reach the same result for linear weak irregularities and the difference is only superficial; but only Kato's theory is applicable to strong irregularities. (auth) (UK)

12647 POSITION AND HEIGHT OF AURORAL ABSORPTION DEDUCED FROM VLF PHASE MEASUREMENTS. Egeland, A.; Larsen, T. R.; Naustvik, E. (Norwegian Inst. of Cosmic Physics, Oslo). J. Atmos Terrest. Phys., 31: 187-92(Jan. 1969).

The main findings from vlf measurements during auroral absorption were as follows: The geographical extent of auroral absorption seemed to be at least a factor of two larger than found by hf riometers. The vlf reflection layer was markedly depressed during auroral disturbances. At night large and rapid fluctuations in the reflection layer appeared to occur simultaneously over distances of more than 500 to 1000 km. During daytime the depressed vlf reflection layer seemed to be relatively homogeneous over the same distances. (auth) (UK)

12648 FLAMING AURORAS. Cresswell, G. R. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 31: 179-83(Jan. 1969).

Several examples of flaming auroras were observed with auroral image orthicon television systems. For assumed lower border heights of 100 km these had upward field-aligned velocities of 70 to 80 km/sec. By assuming the flaming to be due to velocity dispersion and differential atmospheric penetration of electrons of different energies, release points on the station's field line were calculated. These ranged from the equatorial plane to 2.5 R_E along the field line from the ionosphere when the assumed lower border height was allowed to vary from 90 to 110 km. (auth) (UK)

12649 RAY TRACING OF THE Z MODE IN A TILTED-LAYER IONOSPHERE. Papagiannis, M. D.; Miller, D. L. (Boston Univ.). J. Atmos. Terrest. Phys., 31: 155-63(Jan. 1969).

Rays of the Z mode were traced through tilted layers of the ionosphere and it was found that tilted layers can explain the occasional appearance of Z mode echoes in ionograms. It was also found that the type of tilting determines the range of frequencies over which Z-mode echoes are received. This theoretical result agrees with certain ionograms which show an intense spread-F effect for the ordinary and extraordinary modes but show a clear echo for the Z mode which appears only over a limited spectral range. A method was also developed to take into account the existence of a coupling cone around the direction of the magnetic field at $X = 1$ without going through the complicated procedure of a full wave solution. (auth) (UK)

12650 COORDINATED ROCKET MEASUREMENTS ON THE D-REGION WINTER ANOMALY. I. EXPERIMENTAL RESULTS. Sechrist, C. F. Jr. (Univ. of Illinois, Urbana); Mechtly, E. A.; Shirke, J. S.; Theon, J. S. J. Atmos. Terrest. Phys., 31: 145-53(Jan. 1969).

In order to investigate possible associations between D-region warmings and enhanced electron densities on winter days of high radio-wave absorption, nearly simultaneous rocket measurements of D-region temperatures and electron densities were conducted on an anomalous winter day at Wallops Island, Virginia. Ground-based radio-wave absorption measurements on 3.03 MHz and sweep-frequency ionosonde observations revealed that January 31, 1967 was an anomalous winter day, and rockets were launched to measure electron densities, neutral temperatures, and winds in the D region. On February 3, 1967, the 3.03 MHz radio wave absorption had decreased to normal levels and a second rocket-grenade experiment was launched to measure neutral temperatures and winds in the mesosphere. The electron density profile for January 31, 1967 was generally similar to that measured on the anomalous winter day of January 10, 1966, the densities in the 70 to 80 km height range being about five times greater than those on a normal winter day. The rocket-grenade temperature profile for the anomalous day revealed a strong temperature inversion at 70 km and a warm layer extending from the inversion to 84 km; this temperature structure was significantly different from that at the same altitudes on the normal day of February 3, 1967. (auth) (UK)

12651 MINOR ATMOSPHERIC CONSTITUENTS AND THE ION COMPOSITION OF THE E REGION. Monro, P. E.; Bowhill, S. A. (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys., 31: 103-17(Jan. 1969).

An analysis is described of rocket-measured profiles of electron density and relative ion abundances in the E region between heights of 110 and 150 km. The profiles for three conditions are considered, viz., equilibrium daytime and nighttime conditions, and for a period over sunrise. Using published values of solar flux, cross sections, and reaction rates, it is shown that the observed daytime and nighttime O_2^+ and NO^+ abundances cannot be explained unless a reaction of the form $O_2^+ + X \rightarrow NO^+ + Y$, where X is a minor neutral constituent, plays a dominant role. This reaction is important also during sunrise. The results suggest a pronounced solar control on the concentration of X and a relatively high abundance of O_2^+ (about 60%) in the height range 110 to 130 km during sunrise. The range of values deduced for the concentration of X encompasses the published measured values of the concentration of NO in this region. This suggests that NO is the minor neutral constituent involved, although the possibility that N is also important cannot be ruled out. (auth) (UK)

12652 DIURNAL VARIATION OF THE ION TEMPERATURE. Mahajan, K. K. (Arecibo Ionospheric Observatory, Puerto Rico. Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Terrest. Phys., 31: 93-101(Jan. 1969).

Results on the diurnal variation of the ion temperature, obtained from the Thomson scatter spectra at Arecibo, in the height range 250 to 475 km, are presented. At 250 km, where the ion temperature (T_i) is expected to be nearly equal to the neutral temperature (T_n), T_i was generally observed to show diurnal maximum at 16 hr L. T. and diurnal minimum at 4 hr L. T., with no appreciable change in these times with solar activity. The average day to night T_i ratio at 250 km was found to be 1.45. These results are in apparent conflict with the satellite drag analysis in which T_n was found to have a diurnal maximum at 14 hr L. T. and day to night temperature ratio around 1.30. At 475 km, where T_i is significantly above T_n, the diurnal behavior of T_i was observed to be different on different days. The day-to-day and hour-to-hour variations in T_i at this height are found to be due to changes in the electron density and electron temperature and seem consistent in terms of an energy budget that includes heating of the ion gas by the hotter thermal electrons and cooling by the neutral atmosphere. (auth) (UK)

12653 SATELLITE SCINTILLATION AT HIGH LATITUDES AND ITS POSSIBLE RELATION TO PRECIPITATION OF SOFT PARTICLES. Frihagen, J. (Auroral Observatory, Tromsoe, Norway). J. Atmos. Terrest. Phys., 31: 81-92(Jan. 1969).

Results of a study of satellite scintillation on 40 MHz as observed from a station on Spitsbergen are presented. There was a polar region giving rise to scintillation that had a southern boundary at $L \sim 16$ during magnetically quiet days, and expanded at night and during magnetically disturbed conditions to $L < 6$. Within this region there was no systematic dependence of scintillation depth on K_p, time of day, or position. The fading rate increased with increasing fading depth. A simple model whereby ionospheric irregularities are produced by the irregular ionization produced by spatially varying particle precipitation is considered. In order to produce the observed ionosphere irregularities rms spatial variations of 10^{11} particles (m^{-2} sec^{-1}) at 1 keV, with scale of the order 1 km are necessary. The very few available satellite observations do not preclude the possibility of such variations. (auth) (UK)

12654 IRREGULARITIES IN THE LOWER IONOSPHERE DEDUCED FROM BEACON SATELLITE OBSERVATIONS. Holbrook, J. A. D.; Lyon, G. F. (Univ. of Western Ontario, London). J. Atmos. Terrest. Phys., 31: 71-9(Jan. 1969).

Received field strength measurements of the 20 MHz transmission from Explorer 22 were made at London, Ontario, Canada (43°N, 81°W). It was possible to perform such measurements unambiguously only during quiet ionospheric conditions. Most daytime observations showed evidence of the presence of electron density fluctuations, whereas nighttime observations were nearly always smooth. Interpretation of the results in terms of nondeviative absorption along the ray paths suggests that the irregularities observed are occurring at the 70-km height level and are probably the same as those thought to be responsible for the continuous signal received on high-power vhf forward scatter circuits. (auth) (UK)

12655 F REGION SEASONAL AND MAGNETIC-STORM BEHAVIOUR. Duncan, R. A. (Commonwealth Scientific and Industrial Research Organization, Camden, New South Wales). J. Atmos. Terres. Phys., 31: 59-70(Jan. 1969).

A new study of F-region daily behavior supports earlier suggestions of global upper atmospheric circulation and consequent changes of F-region neutral composition, and electron production and loss rates. The study suggests that this circulation arises from both solar and magnetic-disturbance heating. Alone among current theories this appears adequate to explain F-region seasonal and magnetic-storm behavior, and their interrelation. (auth) (UK)

12656 PROBLEMS ASSOCIATED WITH OVERLAY ANALYSIS OF F1-REGION IONOGRAMS. Lawden, M. D. (Dept. of Scientific and Industrial Research, Christchurch, New Zealand). J. Atmos. Terrest. Phys., 31: 47-57(Jan. 1969).

A critical examination was made of a previously published method of analyzing F1-region ionograms. In this method, ionograms are compared with overlays of theoretical h'(f) curves. The "shape factor" G, used to estimate the linear loss coefficient β, becomes ambiguous when electron production is assumed to occur in two different constituents (O and N_2) of varying relative concentration instead of in a single constituent (O). The ratio (measured by a parameter R_0) of the production rates in N_2 and O is a new parameter of great importance. Any temperature variation in the reaction rates is also very important. The parametric values obtained using the overlay method may contain large systematic errors. Nevertheless, the method remains a fast and convenient way of studying both sudden and gradual changes in the state of the F1 region. (auth) (UK)

12657 HEIGHT DISTRIBUTION OF LUNAR TIDES IN THE IONOSPHERE NEAR THE MAGNETIC EQUATOR. Zagulyaeva, V. A.; Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). J. Atmos. Terrest. Phys., 31: 1-13(Jan. 1969).

The results of calculations of the height distribution of the lunar daily variations of electron density are given for the stations Ibadan, Huancayo, and Panama. In addition, for Ibadan calculations were made of the lunar variations of h_{min} and h_{max} and of heights of constant ionization. The relation between the calculated results and the available measured parameters of the layers is discussed. For Ibadan, velocities of the vertical movements of electrons due to lunar tides, and the loss coefficient, were estimated. (auth) (UK)

12658 GRAVITY WAVES IN THE F REGION. Klostermeyer, J. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys., 31: 25-45(Jan. 1969).

Internal atmospheric gravity waves in the F region can be observed on magnetically quiet or slightly disturbed winter nights by means of electron density profiles deduced from vertical incidence ionograms. Phase velocities were obtained by using ionograms of three stations spaced some 100 km apart. In order to interpret these observations the theory of gravity waves appropriate to conditions in the F region was developed. The influence of the inductive deceleration is included, and the linearized equations of motion are solved by a WKB approximation. The perturbation velocity, the energy density, the energy flux, etc., can be deduced from the experimental and theoretical results. A possible origin of the gravity waves is discussed, and the contribution of the inductive deceleration to the observed attenuation of the waves is determined. (auth) (UK)

12659 RADIO EMISSION FROM AURORAL ELECTRONS. Gregory, P. C. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 221: 350-2(Jan. 25, 1969).

Data from the satellite Ariel III indicated that some of the noise bands in the topside ionosphere occurred only when the satellite was within the range of invariant latitude corresponding to the auroral zones, and results from the present studies indicated that these noise bands are probably generated by Cherenkov radiation from auroral electrons of a few keV. Absolute measurements were made of radio noise in the frequency range 1.94 to 4.24 MHz. The distribution of occurrences of the noise bands in the northern hemisphere is shown as a function of invariant latitude and geomagnetic time, indicating confinement to a narrow range of latitude coinciding very closely to the auroral zone. It was apparent that intense fluxes of soft electrons are responsible for the observed noise bands, and generation by Cherenkov radiation is discussed. (UK)

12660 ON THE DAY AND NIGHT REVERSAL IN NmF2 NORTH–SOUTH ASYMMETRY. Abur-Robb, M. F. K.; Windle, D. W. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 97-106(Jan. 1969).

A time-varying solution of the full-continuity equation for electrons in the F2 region is obtained. The effects of production, loss, diffusion, and electrodynamic E × B drift are taken into account. In addition, the effects of a transequatorial neutral wind are included. It is shown that a constant north–south neutral wind can produce distributions similar to the day and nighttime asymmetrical distributions actually observed in the F2 region. The results show that during daytime ionization is transported from one hemisphere to the other in the direction of the wind. The peak in NmF2 on the southern side is greater than the peak on the northern side during the day, and the peaks achieve their maximum values between 16 and 17 hr LT at magnetic latitudes 15.5°S and 15°N, respectively. After 17 hr, the peaks start to decrease, on both sides of the magnetic equator, the southern peak decreasing at a faster rate than the northern peak, until they are equal at about 15° latitude at 20.5 hr; afterwards an asymmetry occurs in the opposite sense until sunrise. These results are compared with observations, and suggest the presence of winds blowing from one hemisphere to the other across the magnetic equator. (auth) (UK)

12661 SPATIAL RELATIONSHIPS BETWEEN HF RADAR AURORA, OPTICAL AURORA, AND ELECTRON PRECIPITATION. Bates, H. F. (Stanford Research Inst., Palo Alto, Calif.); Sharp, R. D.; Belon, A. E.; Boyd, J. S. Planet. Space Sci., 17: 83-95 (Jan. 1969).

Backscatter data (hf) were obtained at College, Alaska, during 16 passes of satellite-borne particle-detectors near the College meridian. On the nightside of the Earth the gross position and the occurrence of precipitating auroral electrons and radar aurora were in good agreement, whereas on the dayside part of the electron precipitation was generally not accompanied by radar aurora. Previous work showed that the precipitation of auroral electrons into the dayside atmosphere occurs in two distinct zones of latitude. The characteristics of the incoming electron flux in the poleward of the two zones correspond to those required for the production of the observed characteristics of the dayside optical aurora in the auroral oval. The hf radar aurora was found to be closely associated in space with the electron flux in the poleward precipitation zone. During a 3-month period when simultaneous optical and hf radar observations were made hourly on the College meridian, 14 instances were found when precise auroral positions could be derived by photometric triangulation. Most of the hf echoes examined originated close to the narrow, discrete auroras used for the triangulation measurements. A study also showed that when no aurora occurred in a given general region, no auroral echoes were received from that region. It is concluded that hf radar aurora are closely associated in time and space with oval aurora, although exact correspondence was not found. The good agreement between the various data indicates that hf radars can track the aurora in the oval with sufficient reliability that the radar data can be used in the study of the morphology of the auroral oval. (auth) (UK)

12662 ELECTROSTATIC WAVES IN THE IONOSPHERE EXCITED AROUND THE LOWER HYBRID RESONANCE FREQUENCY. Horita, Robert E.; Watanabe, Tomiya (Univ. of British Columbia, Vancouver). Planet. Space Sci., 17: 61-74 (Jan. 1969).

The origin of lower hybrid resonance noise, discovered by the Alouette I satellite, is discussed. It is shown that in the ionosphere there are electrostatic waves propagating at large angles to the Earth's magnetic field with frequencies in the vicinity of the lower hybrid resonance. It is also shown that an electrostatic wave propagating slightly off the direction perpendicular to the magnetic field can grow due to the Landau instability process which is excited by high-energy (~10 keV) electrons streaming along the direction of the magnetic field of the Earth. The growing electrostatic wave thus triggered is shown to have a frequency band with a sharp lower cutoff at the lower hybrid resonance frequency, in agreement with observation. (auth) (UK)

12663 GROWTH OF A PACKET OF FINITE AMPLITUDE VERY-LOW-FREQUENCY WAVES, WITH SPECIAL REFERENCE TO THE MAGNETOSPHERE. Knox, F. B. (Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand). Planet. Space Sci., 17: 13-30(Jan. 1969).

Cyclotron resonance interaction of a packet of finite amplitude "whistler" mode waves, traveling in the direction of the ambient magnetic field, with a collection of high-energy electrons spiraling along the field is examined. It is concluded that when the amplitude of a packet of waves becomes large enough, the packet grows in length rather than amplitude. In a uniform medium a wave packet develops, in which the frequency varies monotonically along its length, approaching a quarter of the electron gyrofrequency at the front. The amplitude of the packet is more or less constant with distance along it. Using typical values of magnetosphere parameters, it is shown that, although the nonlinear effects considered should be important, a vlf wave packet in the magnetosphere is not likely to develop in the same way as for a similar uniform medium. (auth) (UK)

12664 IONOSPHERIC ELECTRON DENSITY AND TEMPERATURE VARIATIONS DURING A DAY IN JANUARY. Roberts, William T. (NASA-Marshall Space Flight Center, Huntsville, Ala.). pp 495-7 of Proceedings of the Third National Conference on Aerospace Meteorology, May 6-9, 1968, New Orleans, La. Boston, Mass., American Meteorological Society, 1968.

See CONF-680534.

Results of measurements made by Langmuir probes on payloads launched from Cape Kennedy on January 24, 1967 are presented. (B.G.D.)

12665 TIME-DEPENDENT MOTIONS OF THE CAVITY FORMED WHEN A UNIFORM CORPUSCULAR FLUX IS INCIDENT ON THE MAGNETIC FIELD OF A LINE CURRENT. Hewson-Browne, R. C.; Burghes, D. N. (Univ. of Sheffield, Eng.). J. Plasma Phys., 2: 51-7(Feb. 1968).

The two-dimensional problem is formulated and solved with two particular classes of solutions being given; namely, the steady-state solutions and the time-history of the interaction with a cloud of flux. (auth)

12666 GUIDED PROPAGATION OF ALFVEN WAVES IN THE MAGNETOSPHERE. Fejer, J. A.; Lee, Kai Fong (Univ. of California, San Diego). J. Plasma Phys., 1: 387-406(Nov. 1967).

The guided propagation of Alfvén waves in a cold plasma is discussed from several points of view. First the field of a line source is calculated at infinity. This calculation leads to a divergence in the radiated power in two directions forming very small angles with the magnetic field. The divergence is removed if the line source is replaced by a strip source of finite width. It is shown that propagation from a strip source only a few kilometers wide is strongly guided by the magnetic field, with almost no spreading, along a field line extending up to, say, 4 R_E for wave periods of about 100 sec. Guidance by field-aligned ducts is briefly investigated. It is demonstrated by a numerical example that ducted propagation can occur in field-aligned irregularities only a few kilometers wide in which the electron density is about 15% greater than in the surrounding medium. (auth)

12667 HYDROMAGNETIC COUPLING OSCILLATIONS IN NON-UNIFORM, COLLISIONLESS PLASMAS. Tamao, Tsutomu (Tokyo Univ.). Inst. Space Aeronaut. Sci., Univ. Tokyo, Rep., 33: 97-123(Mar. 1968).

An analysis was made of the thermal effects on resonant coupling hydromagnetic oscillations in inhomogeneous, low-β plasmas, such as that of the Earth's magnetosphere. By applying the drift kinetic approximation, the fundamental equations for the coupling modes between the Alfven and magnetoacoustic oscillations in a non-uniform, collisionless plasma were obtained. There are two thermal effects for such oscillations, the thermal dissipation due to wave–particle resonance interactions and the drift effect from plasma inhomogeneities. For the outer magnetospheric conditions, where $\beta \simeq m_e/m_i$ (m refers to the mass of particles), it was shown that electron thermal dissipation of hydromagnetic oscillations with $\omega/k_{||} \simeq V_A$ (where ω is the angular frequency of perturbations, $k_{||}$ is the wave no. vector, and V_A is Alfven speed) is most effective within the resonance regions which appear in the cold plasma limit. This effect is proportional to ω/Ω_i for the case of continuous distribution of plasma parameters and $(\omega/\Omega_i)^2$ for the stratified distribution, respectively, where Ω_i is the ion gyrofrequency. Attenuation of hydromagnetic waves due to ion–wave interactions may be a possible process for ion heating in the plasma sheet of the geomagnetic tail, and relevant equations are also derived. With a view to applying the results to the magnetospheric plasma, drift wave instabilities in the long wavelength limit are discussed for the most general case, including simultaneously the density, temperature, and magnetic field gradients, as well as the ion Larmor radius effect. (BBB)

12668 RESULTS ON VLF OBSERVATION BY THE DOSHISHA UNIVERSITY ALASKA EXPEDITION, 1964. ELECTRON DENSITY IN THE MAGNETOSPHERE DEDUCED FROM NOSE WHISTLERS. Nakano, Minoru; Kitamura, Tai-ichi (Kyoto Univ.). Sci. Eng. Rev. Doshisha Univ., 9: 1-8(May 1968).

The electron density in the magnetosphere, using the data obtained at base camp beside Nabesna Glacier in the Wrangell Mountains Alaska (64°N geomagnetic) as well as those at Port Wrangell, Alaska (60°N geomagnetic), is examined and compared with earlier results. The values of electron density agree well with earlier ones, but disagreement on the position of the plasmapause is found. Several remarkable knee whistlers were observed on Sept. 14, 1964 at Port Wrangell. The mean equatorial profile of the electron density during day time (1100 to 1200 LT) in the magnetosphere shows an abrupt change of the electron density (the plasmapause) at about L = 5. The electron density differs by a factor of 2 between the two sides of the knee. The density outside the knee, about 30 to 50 electrons cm^{-3}, decreases almost proportionally to r^{-3}. Disagreement of results with earlier work suggests that the location of the knee may vary from year to year. The knee may possibly be located at a shorter distance from the earth in the active solar year (1958), but in the quiet year (1964) the location may move outwards. To parallel this, when the magnetic conditions become very quiet ($K_p = 0-1$), a higher latitude position (Byrd, 71°S) becomes more favorable for knee observations than a lower one (Eight, 64°S). A discrepancy in electron density outside the knee boundary is not solved. A higher density (~50 particles/cc) has resulted from a geomagnetic pulsation study (Kitamura and Jacobs 1967) as well as IMP II observation. (BBB)

12669 ELECTRON DENSITY DISTRIBUTION ABOVE THE WINTER POLE. Andrews, M. K.; Thomas, J. O. (Imperial Coll. of Science and Tech., London). Nature (London), 221: 223-7(Jan. 18, 1969).

Measurements by the Alouette I satellite over the winter pole have revealed an electron density distribution which is stationary with respect to the Sun. The chief feature is a ring of high density plasma throughout the height range accessible to the satellite. (auth) (UK)

12670 THEORY OF THE DIFFUSIVITY FACTOR FOR ATMOSPHERIC RADIATION. Armstrong, B. H. (IBM Scientific Center, Palo Alto, Calif.). J. Quant. Spectrosc. Radiative Transfer, 8: 1577-99(Sept. 1968).

The definition of the diffusivity factor r, given by Yamamoto and by Plass, wherein the exponential integral $E_3(\tau)$ arising from the angular integration in the radiative transmission function is replaced by $\frac{1}{2}e^{-r\tau}$, is discussed. A value of r can be obtained from this definition such that the replacement is exact due to the cancellation of the difference when the frequency integration is carried out. This definition is applied to the line shapes and band models of primary interest in atmospheric physics and astrophysics; although a few analytic solutions exist, most of the models must be solved by numerical calculation. Such calculations were carried out and the results are presented graphically so that diffusivity factors can be easily obtained for practical problems, as is illustrated by an example. An approximation is developed for water vapor which yields the result $r = \sqrt{e} = 1.649$ almost independently of the problem variables. (auth) (UK)

12671 METHOD OF DETERMINING THE S_q VARIATION AND THE SYSTEM OF S_q CURRENTS IN THE IONOSPHERE. Ivanov, K. G.; Mikerina, N. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 8: 297-9(1968).

Translated from Geomagn. Aeron., 8: 368-9(1968).

Recent radar investigations of the equatorial ionosphere (Balsley, Ann. Geophys., 22: 460(1966)) revealed that the flow of electrons in the electrojet reverses direction (from westward to eastward) at about 20h LT. Consequently, at this time the density of the ionospheric current at the equator crosses zero, and it is natural to select the field value at this hour as the zero level, i.e., $\Delta F_i = F_i - F_{20}$. Although observations have been made only at the equator the authors assume that the zero reference level at 20h deviates little at other latitudes; this assumption was used, along with data of hourly values from 24 observatories in the Asiatic zone (June 1958), to determine the S_q variation. The ΔF_i values computed by this method were used to construct an S_q current system by the graphical integration method. This S_q current system is then compared with corresponding current systems determined by former methods, using variations for the same stations and the same time. (W.D.M.)

12672 CROSS MODULATION IN A NONLINEAR DISPERSIVE PLASMA. Ram, Sant (Indian Inst. of Tech., New Delhi). Radio Sci., 4: 191-6(Feb. 1969).

Expressions for the electric vector of the first- and the second-order cross modulation have been derived for an amplitude-modulated wave propagating in a nonlinear dispersive medium as well and for a normally incident wave reflecting back into free space from the plasma free-space interface. In the discussion, some numerical results illustrating the variation of the cross modulation with different plasma parameters are presented in tabular form. (auth)

12673 PLASMA IN THE MAGNETOSPHERE. **Scarf, Frederick L.** (TRW Systems, Redondo Beach, Calif.). **Advan. Plasma Phys., 1: 101-52(1968).**

Review-type discussions are given on the following: (1) structure of the magnetosphere, (2) thermal plasma in the magnetosphere, (3) energetic particles, and (4) waves in the magnetosphere. (M.O.W.)

12674 ROLE OF THE UNIVERSAL INSTABILITY IN AURORAL PHENOMENA. **D'Angelo, N. (ESRIN, Rome). J. Geophys. Res., 74: 909-13(Feb. 1, 1969).**

The relevance of the universal instability theory to the observations of pulsating (optical) auroral and fast quasi-periodic variations of the auroral x-ray fluxes is discussed. The principal result of the present investigation is that a good correlation exists between the temporal and spatial variations of particle precipitation and the properties that might reasonably be expected from a drift-wave model. (W.D.M.)

12675 DISCUSSION OF LETTER BY PETER M. BANKS AND J. WILLIAM McGOWAN, He_2^+ IN THE TOPSIDE IONOSPHERE. **Gerardo, J. B.; Gusinow, M. A. (Sand Labs., Albuquerque, N. Mex.). J. Geophys. Res., 74: 919-21(Feb. 1, 1969).**

Two production mechanisms for the production of He_2^+ in the topside ionosphere are briefly discussed and it is mentioned that Banks and McGowan (1968) may have dismissed the Hornbeck–Molnar process without justification. A reply by Banks and McGowan is included. (W.D.M.)

12676 DISCUSSION OF PAPER BY Y. KONDO AND J. E. KUPPERIAN, JR., INTERACTION OF THE NEUTRAL HYDROGEN AND CHARGED PARTICLES IN THE RADIATION BELTS: THE CONSEQUENT LYMAN-ALPHA EMISSION. **Shefov, N. N. (Inst. of Physics of the Atmosphere, Moscow). J. Geophys. Res., 74: 922-6(Feb. 1, 1969).**

Several points in the paper by Kondo and Kupperian are discussed. A reply by Kondo and Kupperian is included. (W.D.M.)

12677 FIELD-ALIGNED IONIZATION SCATTER GEOMETRY. **Millman, George H. (General Electric Co., Syracuse, N. Y.). J. Geophys. Res., 74: 900-5(Feb. 1, 1969).**

An evaluation was made of various computational techniques for determining: (1) the magnetic field geometry for backscatter reflections and (2) the locations on the Earth's surface for the reception of magnetic-field forward scatter from a given transmitter location. A graphical technique is discussed that utilizes ground-observed magnetic data scaled from isogonic and isoclinic maps. The theoretical methods also considered are (1) the dipole method, which is based on the supposition that the Earth's magnetic field can be approximated by the field of a magnetic dipole located at the Earth's center, and (2) the spherical harmonic method, which assumes that the Earth's main field can be represented by a regular or simple dipole field and an irregular field. (W.D.M.)

12678 OGO 3 OBSERVATIONS OF ELF NOISE IN THE MAGNETOSPHERE. I. SPATIAL EXTEND AND FREQUENCY OF OCCURRENCE. **Russell, Christopher T. (Univ. of California, Los Angeles); Holzer, Robert E.; Smith, Edward J. J. Geophys. Res., 74: 755-77(Feb. 1, 1969).**

The magnetic noise in the magnetosphere in the frequency range from 10 to 800 Hz has been extensively measured by the spectrum analyzers of the search coil magnetometer on OGO 3. A statistical study is presented here of the spatial extent and frequency of occurrence of noise at the higher end of this passband, at which frequencies noise above the detector thresholds is most common within the magnetosphere. Steady noise and noise bursts are found to constitute two distinct populations. Both the local-time and magnetic latitude distribution of both classes of signals are investigated. When the magnetic latitude distributions are extrapolated downward to 1000-km altitudes, the results are consistent with previous satellite observations at these low altitudes. However, the equatorial distributions cannot be inferred by simply projecting the magnetic noise measured at low altitudes onto the equator along flux tubes. The in situ measurements cannot determine the exact location of the source of all the noise observed. However, it is found that steady noise is definitely generated near 45° magnetic latitude on the dayside of the magnetosphere for L values from 6 to 10 and that bursts are generated near the equator above L = 6 from 0400 to 1800 local time. The latter observation can be used to explain the generation of both auroral microbursts and chorus as seen on the ground by means of whistler mode wave growth at the equator supported by a pitch-angle anisotropy maintained by the loss cone. (auth)

12679 STANDING ALFVEN WAVES IN THE MAGNETOSPHERE. **Cummings, W. D. (Univ. of California, Los Angeles); O'Sullivan, R. J.; Coleman, P. J. Jr. J. Geophys. Res., 74: 778-93(Feb. 1, 1969).**

Transverse, low-frequency oscillations in the magnetic field have been recorded in the equatorial plane at 6.6 R_E with the UCLA magnetometer on board ATS 1. The oscillations have peak-to-peak amplitudes of 2 to 20 γ and have been observed predominantly on geomagnetically quiet days in the morning and noon quadrants. The fluctuations are very nearly monochromatic, and those with periods ranging from 50 to 300 sec have been studied. This paper reports on observations made during January 1967, when 25 separate events were recorded with durations ranging from 10 to 400 min. The oscillations could be grouped into two period ranges, one centered about T = 190 sec and the other about T = 102 sec. The oscillations were confined to a plane that was approximately perpendicular to the main magnetic field vector. They were generally elliptically polarized in this plane, with the major axis of the polarization ellipse typically inclined eastward at an angle of ≃30° to the radially outward direction. An MHD analysis is given for an idealized model in which the Earth is considered a perfect conductor, the background magnetic field is that of a dipole, and the plasma density varies as a power law. For the case of a standing Alfvén wave the poloidal and toroidal wave equations uncouple. These equations are solved numerically, and the eigenfrequencies appropriate to the synchronous orbit are tabulated for the first six harmonics for seven density models. From the results of the analysis it is argued that the observed transverse oscillations are the second harmonic of a standing Alfvén wave. Under this interpretation the data are consistent with the hypothesis that the plasmapause is beyond 6.6 R_E only during very quiet periods. (auth)

12680 SOME OBSERVATIONS OF ENERGETIC ELECTRONS IN THE OUTER RADIATION ZONE DURING MAGNETIC BAYS. **Rao, C. S. R. (Univ. of Iowa, Iowa City). J. Geophys. Res., 74: 794-801(Feb. 1, 1969).**

Changes in the cutoff boundary latitude and flux of electrons $E_e > 40$ keV in the midnight sector of the outer radiation belt during periods when magnetic bays are in progress are studied in this paper from the data obtained by Injun 4. From this study, it is observed that (1) the outer-zone flux in the midnight sector increases without any change in the boundary latitude during the expansion phase of a magnetic bay and (2) in addition to the increase in flux, there is also an extension of the boundary to higher latitudes during the recovery phase of a magnetic bay. From these observations, it is suggested that magnetic field line merging may not play a primary role in the production of energetic auroral electrons and that acceleration of particles takes place in the outer zone itself and not far out in the magnetotail. (auth)

12681 TOPSIDE RESONANCES AS OBLIQUE ECHOES. **McAfee, J. R. (ESSA, Boulder, Colo.). J. Geophys. Res., 74: 802-8(Feb. 1, 1969).**

The resonance observed by topside sounders at the plasma frequency is explained in terms of slowly propagating waves that reflect obliquely and intercept the satellite. The analysis is an extension of previous work to include the effects of a nonhorizontal magnetic field and propagation out of the magnetic meridian. The returning signal exhibits a characteristic "ringing" or long continuous response. Furthermore, a beating between two waves of slightly different frequencies takes place during the latter part of the response. This accounts for the fringes observed in the resonance. (auth)

12682 RAY TRACING STUDIES FOR THE TOPSIDE IONOSPHERE. **Colin, Lawrence (Ames Research Center, Moffett Field, Calif.); Shmoys, Jerry; McCulley, Geraldine. J. Geophys. Res., 74: 809-14(Feb. 1, 1969).**

The effects of nonvertical propagation on high-altitude topside sounder data reduction are investigated. Although the extraordinary, ordinary, and Z rays exhibit significant lateral deviation in a spherically stratified ionosphere, the resultant effects on analysis accuracy are generally tolerable; however, ionospheric tilts produce very large effects. The joint use of the three modes for future analyses is suggested. (auth)

12683 SOUNDING ROCKET MEASUREMENTS OF ION COMPOSITION AND CHARGED PARTICLE TEMPERATURES IN THE TOPSIDE IONOSPHERE. **Maier, E. J. R. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 815-23 (Feb. 1, 1969).**

The concentrations of H^+, He^+, and ($O^+ + N^+$) were measured as a function of altitude from 300 to 600 km by means of an ion mass spectrometer. The major constituent was found to be O^+ over the entire altitude range, decreasing from >99% of the total ion concentration at 300 km to 88% at 600 km. Hydrogen and helium ions were present as minor constituents increasing with altitude to 11% and ~1%, respectively, at 600 km. At the same time, the electron and total ion concentrations and temperature were measured and compared by means of retarding potential analyzers. The ion temperature was found to increase from 1100° at 300 km to 1600° at 600 km. Electron temperatures were found to increase rather sharply in the 400- to 500-km altitude range from the fairly typical value of 2500° to the very high value of 3500° at 600 km. Comparisons with the electron concentration profiles obtained from the Wallops Island ionosonde station and from the topside sounder Alouette 2 showed good agreement. Relationships among the observables and with the inferred neutral gas temperature of 1060° are discussed. (auth)

12684 TIME AND LATITUDE VARIATIONS OF BLANKETING SPORADIC E OF DIFFERENT INTENSITIES. **Reddy, C. A.; Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). J. Geophys. Res., 74: 824-43(Feb. 1, 1969).**

An in-depth study of blanketing sporadic E (E_s) layers at temperate latitudes was carried out with the purpose of clearly establishing many pertinent details of their temporal and latitudinal variations. A new method of analysis was used in which blanketing E_s layers were separated into four groups according to their intensity, which is defined in terms of the ratio (f_bE_s/f_0E). From an analysis of eight-years' (1958–1965) data of hourly f_bE_s values at ten stations, it was possible to establish, for the first time, that (1) E_s layers of different intensities show different daytime variations with regard to their occurrence, and (2) there is a clear-cut change from higher to lower midlatitudes in the pattern of these daytime variations. It is shown that the daytime E_s occurrence does not go through two maxima at all latitudes and in all seasons. The seasonal and solar cycle variations in the average f_bE_s and in the percentage occurrence of E_s layers in each group are also shown. The f_bE_s values of intense E_s layers show a marked decrease with decreasing solar activity, and this indicates the existence of solar cycle variation in the neutral wind shears and possibly in other relevant parameters in the E region. On the other hand, the occurrence of "intense" and "moderately strong" E_s layers shows an increase with decreasing solar activity. Both features are shown to be consistent with the conclusions of wind-shear theory. A careful analysis of the E_s variations with geographic latitude and with H (the horizontal component of geomagnetic field) has produced no unambiguous evidence for the dependence of E_s occurrence or f_bE_s on H; and the inability of the present analysis to bring out this theoretically predicted dependence is attributed to the possibility that significant variations of neutral wind shears with latitude and geographic location can easily obscure the dependence on H. It is shown that the abnormally high incidence of "intense" E_s layers at Kokubunji is a purely summertime phenomenon. It is pointed out that this high incidence at Kokubunji cannot be explained in terms of the large H value alone, but the occurrence of very strong wind shears at this station has to be assumed. It is emphasized that much self-restraint is needed against making simplistic statements about the observed morphological characteristics of sporadic E. (auth)

12685 NIGHTTIME EQUATORIAL Pi 2 MICROPULSATIONS. **Kannangara, M. L. T.; Fernando, P. C. B. (Univ. of Ceylon, Colombo). J. Geophys. Res., 74: 844-52(Feb. 1, 1969).**

The analysis of nighttime Pi 2 micropulsations recorded at Colombo, over an uninterrupted period of one year from October 17, 1964, to October 16, 1965, indicates that (1) Pi 2 events are most prominent, especially about midnight, during the equinoxes; (2) the rate of occurrence of Pi 2 events increases almost linearly with Kp up to a Kp level of at least 5; (3) the dominant periodicity of Pi 2 events shows a definite Kp dependence, the median shifting smoothly from a value of about 100 seconds at the Kp = 0 level to about 45 seconds at the Kp = 5 level; and (4) Pi 2 oscillations tend to have longer periods when they occur at or immediately before midnight, and to have shorter periods when they occur at predawn. (auth)

12686 ROCKET MEASUREMENT OF NITRIC OXIDE BETWEEN 60 AND 96 KILOMETERS. **Pearce, J. B. (Univ. of Colorado, Boulder). J. Geophys. Res., 74: 853-61(Feb. 1, 1969).**

The height profile of the nitric oxide airglow in the gamma bands ($A^2\Sigma^+ - X^2\Pi$) is presented from measurements by a sounding rocket at evening twilight. The nitric oxide density profile is deduced from these measurements. The density profile is used to deduce the dominant processes controlling nitric oxide in the 60- to 96-km range. Above 75 km the dominant process is found to be atmospheric mixing. The chemical reaction of nitric oxide with ozone is suggested as the dominant process below 70 km. (auth)

12687 ENERGY PROPAGATION IN THE LOWER IONOSPHERE AND ATMOSPHERE PRODUCED BY ARTIFICIAL DISTURBANCES. I. **Fehr, Uri (Columbia Univ., Palisades, N. Y.); McGahan, L. C. J. Geophys. Res., 74: 868-75(Feb. 1, 1969).**

A series of medium-size explosions were monitored by a variety of ground sensors. A preliminary study of one typical explosion at 250 meters above the ocean surface revealed many interesting results; from the acoustical signal the effects of the atmosphere on infrasonic waves generated as a pulse were identified both as a function of frequency and as a function of distance. Vlf and elf electromagnetic signals were observed by stations more than 100 kilometers from the explosion center. The signals are described fully, and the experimental objectives are summarized. (auth)

12688 SCINTILLATION BOUNDARY. **Aarons, J.; Mullen, J. P.; Whitney, H. E. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 74: 884-9(Feb. 1, 1969).**

The high-latitude transition or boundary between high and low amplitude fluctuations of satellite radio beacon signals was examined as a function of time. The boundary of the scintillation region reaches its lowest latitude (54° geomagnetic north) between 1930 and 2230 local time. The most northerly boundary latitude of approximately 80° geomagnetic north occurs during the period of 1030 to 1330 local standard time. General agreement is demonstrated between the observations of Transit 4 at 54 MHz at a subauroral site, Explorer 22 at 40 MHz at three sites, and the main zone of discrete auroral events and precipitation of low-energy particles as shown by Piddington (1965) and Hartz and Brice (1967). High amplitude scintillations poleward of the auroral oval and soft electron precipitation in this latitude range show similar characteristics. (auth)

12689 PERIODICITIES IN THE AMPLITUDE OF IONOSPHERIC PLASMA RESONANCES. **Fejer, J. A.; Schiff, M. L. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 74: 890-3(Feb. 1, 1969).**

No satisfactory theoretical explanation of these periodic fluctuations has yet been offered. A new hypothesis is proposed in terms of quasi-electrostatic "surface waves" guided by the antenna wire. It is suggested that the periodic fluctuations seen on the fringe patterns described by Calvert and VanZandt (1966) are a manifestation of a slow beat frequency between two closely spaced antenna resonant frequencies. (W.D.M.)

12690 EVIDENCE FOR A HELIUM FLUX IN THE LOWER THERMOSPHERE. **Kasprzak, W. T. (Univ of Minnesota, Minneapolis). J. Geophys. Res., 74: 894-6(Feb. 1, 1969).**

The diffusion theory presented by Hirschfelder et al. (1964) for a multicomponent gas mixture was used to determine the equation for the equilibrium distribution of a minor constituent with an associated transport flux. It was assumed that the temperature T(z), total number density n(z), and mean molecular mass $\langle m(z)\rangle$ at altitude z satisfy the hydrostatic equation $d\ln(nT)/dz = -\langle m\rangle g/kT$ where g(z) is the local gravitational acceleration and k is Boltzmann's constant. (W.D.M.)

12691 BEARING DEVIATION IN HIGH-FREQUENCY TRANSIONOSPHERIC PROPAGATION. 3. RAY TRACING INVESTIGATION OF THE MAGNETOIONIC EFFECT. **Rao, N. Narayana** (Univ. of Illinois, Urbana). Radio Sci., 4: 153-61(Feb. 1969).

The influence of an earth-centered dipole magnetic field upon the bearing deviation of medium-range hf ray paths in the ionosphere is investigated by using the ESSA three-dimensional computer ray tracing program for a variety of conditions involving quasi-parabolic layer models and actual electron density profiles deduced from ionograms gathered during a direction-finding experiment. The adequacy of the dipole model is examined by comparing the bearing deviations obtained from it with those for a magnetic field based upon spherical harmonic expansion using Gaussian coefficients. (auth)

12692 CONCERNING CERTAIN QUESTIONS OF ORIGIN AND MAINTENANCE OF COSMIC MAGNETIC FIELDS. **Yavorskaya, I. M.** Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 3-10 (July-Aug. 1968). (In Russian).

In the mechanism for origin of magnetic fields according to Birman, conditions are imposed on movement and characteristics of completely ionized plasma, that are necessary for appearance of vortical emf. In this case, the axially symmetric movement of highly conductive plasma can generate toroidal magnetic fields of significant quality. Further, in the kinematic approximation, the problem is resolved for determination of the magnetic field and flow that emerge in the plasma spherical volume, according to models of stars. This volume is rotated around a certain axis with a given angular velocity, depending on the spherical coordinates R and Θ. For specific estimates, characteristics are compared with average characteristics of the model of the sun. (tr-auth)

12693 ROLE OF RADIATION IN FORMATION OF THE SOLAR WIND. Bisnovatyi-Kogan, G. S. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 182-3(July-Aug. 1968). (In Russian).

The role of radiation of the coronal gas in the acceleration of the solar wind was studied earlier by Lifshits who found that this radiation is comparable with the kinetic energy of the solar wind. Heating of the gas in a subsonic field at the expense of the wave dissipation and the thermal conductivities and cooling in supersonic fields at the expense of the radiation of the accelerated gas provide transitions through the sound velocity. The action of these factors is analogous to the action of a hydrodynamic thermal jet considered in another model, in which only the sources of heating are presented. The acceleration in supersonic flow is less compared to the case of absence of these sources. (tr-auth)

12694 PREDICTION OF THE IONOSPHERIC INDEX ϕ. Joachim, Miroslav; Glinz, Christophe. Telecommun. J., 35: 328-33(July 15, 1968).

A method for predicting the ionospheric propagation index ϕ is described for which the relative deviations are less than the relative deviations corresponding to the predictions of other ionospheric indices obtained by different methods. By using a computer, it was possible to calculate by the least-squares method the coefficients of the polynomials that can be filled to a regular series of observations up to $n = 100$, not only for a 2nd-degree function but also for 3rd- and 4th-degree functions. A value of $n = 36$ was finally chosen as a basis for further work; the 10 monthly predictions of ϕ' are calculated on the basis of 36 monthly observations of ϕ for each of the degrees 2, 3, and 4. It was possible to make a posteriori predictions of ϕ for every month since February 1950. Comparison of the predicted and observed values yielded information on the accuracy of the method. The statistical distribution of the relative errors is more or less gaussian. To conform with actual observation, predictions >286 or <67 were excluded. By applying the corresponding correction factors, it was possible to center the predictions and thus obtain a prediction closer to a gaussian distribution. A monthly analysis of the mean errors over the previous 12 months was prepared to facilitate current analysis of the predictions. The procedure of the FORTRAN programs written is outlined. (BBB)

12695 UNDISTURBED MAGNETIC FIELD OF THE EARTH. Siebert, Manfred (Univ., Goettingen, Ger.). Bild Wiss., 5: 27-37(Jan. 1968). (In German).

Origins of the studies of the Earth's magnetic field are described. Drifts in secular variation are reviewed, and studies such as archeo- and paleomagnetism outlined. Fundamental aspects of the magnetic field are touched upon; the primary cause is ascribed to electrical current systems in the interior of the Earth. Studies of the exterior parts of the field by rocket and satellites, and the extension of this sort of study to the magnetic fields of other planets, are described. Results of studies of Mars and Venus are noted briefly. Characteristic electromagnetic waves of Jupiter are mentioned. The importance of further study of the magnetic field of Jupiter for better understanding of the magnetic field of the Earth is underscored. (BBB)

12696 MAGNETOSPHERIC STUDIES USING BALLOON-BORNE INSTRUMENTATION. Barcus, James R.; White, Frank E.; Williamson, Paul R. (Univ. of Denver, Colo.). Antarctic J. U. S., 3: 115-17(July-Aug. 1968).

A second series of high-altitude balloon flights was conducted from Byrd Station during January and February 1968, and a similar series of flights was carried out in an area that is magnetically conjugate to that of Byrd Station, near Hudson Bay in northern Canada. Two intervals of enhanced solar activity occurred during the flight series although the resulting levels of geophysical disturbance were not particularly outstanding. Nevertheless, typical auroral-zone activity was frequently encountered. At 1440 UT (0640 Byrd local time) on January 26, a very rapid and pronounced increase in bremsstrahlung x radiation was observed by the instruments at 8 g/cm^2 residual atmospheric depth. This increase was due to the bombardment of the upper atmosphere by electrons with energies exceeding 20 keV. The electron precipitation coincident with the sudden commencement was highly structured in time. The more intense and enduring precipitation, which followed the sudden commencement by 40 min, was exceedingly smooth. The present results are quite dissimilar to earliest sudden-impulse events. Between 1500 and 1600 UT on February 3, a microburst event was recorded. In the early part of the event, the microbursts occurred principally as single, isolated structures. Approximately midway through the event, double- and triple-burst structures predominated, with a well-resolved temporal separation of 1 to 2 sec within a given group. Toward the end of the event, more complicated structures were seen, but still with a similar intragroup spacing. For an interval of about 1 min, a 6-sec periodicity appeared in isolated microbursts; a persistent intra-group spacing of 1 to 2 sec frequently appeared. Commencing with the microburst activity and continuing throughout its duration, similarly structured vlf emissions at Byrd Station and its magnetic conjugate, Great Whale River, Canada, were recorded. (BBB)

12697 CONJUGACY OF VISUAL AURORAS DURING MAGNETICALLY DISTURBED PERIODS. Belon, A. E. (Univ. of Alaska, College); Davis, T. N.; Glass, N. W. Antarctic J. U. S., 3: 117-19(July-Aug. 1968).

Optical measurements of auroras near magnetically conjugate points provide information on distortions of the geomagnetic field caused by solar-wind pressure and electric currents within the magnetosphere and on the source and trajectories of the auroral particles. To investigate the conjugacy of auroras over a wider range of latitudes and, hopefully, during periods of greater magnetic activity, a series of five NC-135 conjugate flights was made during the new moon period of the 1968 spring equinox. The flights were made during a magnetically disturbed period with College K indices of 5 and 6 on March 24, of 2 and 6 on March 26, of 3 and 3 on March 28, of 4 and 4 on March 29, and of 5 and 5 on April 1. The first auroral form was encountered between dip latitudes 62 and 64°, as a widespread and diffuse H arc, closely conjugate and very similar in shape and intensity in both hemispheres. Detailed features of the auroras appeared to become less similar with increasing latitude. Above dip latitude 67°, auroras which exhibited a degree of similarity were often displaced by several tens of km from conjugate locations calculated on the basis of an internal geomagnetic field. In one case at dip 72°, if an apparent nonconjugacy were due to an intensity difference between hemispheres, the southern aurora would have been at least 100 times weaker than the northern aurora. It appears that the hydrogen arc and the region immediately poleward of it are always within the domain of closed field lines, while auroras above dip latitude 65° are in a transition domain where large stretching and perhaps opening of the field lines occurs in that auroral particles are not guided directly across the equatorial plane. (BBB)

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Refer also to abstracts 12979, 12991, and 13006.

12698 (AI-AEC-12721, pp 329-38) PHYSICAL RESEARCH PROGRAM. Breckenridge, R. G.; Barnes, L. J.; Fink, H. J.; Tomasch, W. J. (Atomics International, Canoga Park, Calif.).

Brief reviews are given of work done at Atomics International during this period on the electronic structure of metals and alloys. In general, the work is directed toward superconductors. (M.O.W.)

12699 (BNL-13200) BEAN MODEL OF AC LOSSES IN TYPE II SUPERCONDUCTORS. Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.). Dec. 16, 1968. 8p. Dep. CFSTI.

Two cases of application of the Bean model to computation of ac losses in type-II superconductors are presented in detail. The first is for a slab geometry with field parallel to the surface of the slab. The second is for the case of external field perpendicular to the axis of a round wire. Both cases are derived for the external field high enough to cause field penetration to the center of the conductor, with no net transport current. (M.H.R.)

12700 (SC-T-69-1002) PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LEAD. Eichler, A.; Wittig, J. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from excerpt of Z. Angew. Phys., 25: 319-22(1968). 9p. Dep. CFSTI.

An abstract of the complete original article appeared in NSA 23: 1315. (L.M.T.)

12701 CONSERVATION OF CIRCULATION THEOREM FOR SUPERFLUIDS. Saffman, P. G. (California Inst. of Tech., Pasadena). Phys. Fluids, 11: 2505-7(Dec. 1968).

The reversible two-fluid equations of helium II are shown to possess two integrals of circulation. The first, which expresses conservation of circulation in the superfluid, is well known, but the second, which expresses conservation of the line integral of $\rho_n(u_n - u_s)/(\rho s)$ around a circuit moving with the normal fluid, appears to be new. (auth)

12702 A LIQUID HELIUM MOESSBAUER ABSORBER CRYOSTAT. Bunbury, D. St. P.; Cain, W. R. A.; Snyder, R. E. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods, 67: 355-6(Jan. 15, 1969).

A cold-finger cryostat which fits onto a standard liquid helium storage dewar is described. The cryostat is useful in Moessbauer experiments for studying an absorber at a low temperature when low liquid helium consumption and easy demountability are required. An absorber temperature of 5 to 6°K is reached with a liquid helium boil-off rate of 1 – 1.5 l/day. (auth)

12703 NOVEL SUPERCONDUCTING LABORATORY DEVICES. PART I. INTRODUCTION TO SUPERCONDUCTIVITY, THE JOSEPHSON EFFECT, AND TUNNELING. Matisoo, Juri (International Business Machines Corp., Yorktown Heights, N. Y.). Anal. Chem., 41: 83A–6A(Jan. 1969).

The Josephson effect is outlined and three laboratory instruments are described. These are of interest for measuring very small magnetic fields ($\sim 10^{-10}$ G) and very small voltages ($\sim 10^{15}$ V) and in fast-response, sensitive infrared detectors ($\tau < 10^{-8}$s; 5×10^{-13} W). (W.D.M.)

12704 MAGNETICALLY COUPLED SUPERCONDUCTORS. Cladis, Patricia Elizabeth Ruth. Rochester, N. Y., Univ. of Rochester, 1968. 184p.

Thesis.

An empirical study was made of the dc transformer effect between magnetically coupled superconductors reported first by Giaevar. This effect provides the most convincing proof of current-induced flux flow. The vortices in one film (called the secondary) are set in motion as a result of their magnetic coupling to the moving vortices in a second nearby film (called the primary). The primary vortices are driven by the Lorentz force resulting from crossed magnetic and electric fields. The two films are separated by a thin insulating layer. The purpose of the present study was to determine the effect of sample parameters, temperature, magnetic field and primary current on the transformer effect. Studies were made of Sn/SiO/Sn sandwiches the Sn films being type-I films which exhibit the vortex structure in perpendicular fields, and $In_{1-x}Pb_x/SiO/In_{1-x}Pb_x$ films, which are type-II films. It was found that as a result of the temperature and magnetic field dependences of the minimum and maximum primary currents (for which the transformer effect exists) the effect is observable only over a narrow temperature interval. For the Sn sandwiches this interval is $0.93 \leq T/T_c \leq 1.00$ and for $In_{0.92}Pb_{0.08}$ sandwiches, $0.77 \leq T/T_c \leq 1.00$. The coupling constant α, defined as the ratio of the secondary and primary voltages, was measured for the alloy sandwiches as a function of temperature, magnetic field, primary current and thickness of the SiO layer. The results are, briefly, that increasing the magnetic field, increasing the thickness of the SiO layer, or decreasing the temperature reduces the coupling. In some cases a nonmonotonic dependence of α on the primary current was found. All of these results are explained, at least qualitatively. A new functional relation was found relating the primary current to the secondary voltage (viz. $\ln I \alpha \sqrt{V}$) in the dc transformer. The same relation was found to describe the nonlinear part of the flux flow curves of bulk type-II superconductors. (Disser. Abstr.)

12705 INTERACTIONS BETWEEN ORGANIC MOLECULES AND SUPERCONDUCTORS. Gamble, Fred Ridley Jr. Stanford, Calif., Stanford Univ., 1968. 167p.

Thesis.

Electronic and vibronic mechanisms similar to those thought to be responsible for superconductivity in metals are also available in molecules; but most molecules or molecular aggregates are not even potentially superconducting. Even so, by coupling molecules to a metal through chemical bonds it should be possible to take advantage of the electrical and vibrational states of the molecules. Interactions between the conduction electrons of the metal and these molecular states might be effective in stabilizing the superconducting state, thus raising the temperature at which superconductivity will occur. Such systems can be prepared by the deposition of selected molecules on thin metal films or by the simultaneous deposition of the molecules and the metal atoms. Experiments of both types have been performed. It was shown that molecules with low electronegativity increase the critical temperature of vanadium films approximately 5%, and that those with high electronegativity have the opposite effect. Films of aluminum, thallium, indium, tin, and lanthanum were also studied. Alloys of vanadium, niobium, and aluminum with organic molecules were prepared. The critical temperatures of vanadium and niobium were depressed. That of aluminum was raised to approximately 5.2°K. Changes in the critical temperature produced by surface coatings are possibly the result of electrostatic charging. Changes produced by simultaneous condensation of the superconductor and the organic molecules are most likely the result of the well known but poorly understood disorder effect. (Disser. Abstr.)

12706 ULTRASONIC ABSORPTION IN SUPERCONDUCTORS WITH ELECTRON–PHONON INTERACTION. Kresin, V. Z.; Medvedev, Yu. V. (Inst. of Correspondence, Moscow). Fiz. Metal. Metalloved., 26: 182–4(July 1968). (In Russian).

Ultrasonic absorption by anomalous superconductors (such as Pb, Hg, Nb, NbN, Ga, and Bi foils) was studied, using the previously developed theory of strong-bond superconductors. The formulas show that the ultrasonic absorption in superconductors with a strong bond can be described by ordinary formulas except for the function of ΔT (the energy gap) which corresponds to the strong-bond superconductor. (R.V.J.)

12707 PROPERTIES OF SOLID INSULATORS AT CRYOGENIC TEMPERATURES. Bobo, J.; Perrier, M. Rev. Gen. Elec., 77: 605–9(June 1968). (In French).

The effects of cryogenic temperatures on the dielectric properties of solid insulators are examined. The apparatus used for these studies is described, the different instruments for determination of dielectric strength in He and in vacuum being illustrated. The loss tangent is also determined in a method outlined for 4.2°K and 50 Hz based essentially on calorimetry. These values are determined as a function of temperature. Diminution of dielectric loss is different for polar and apolar materials at low temperatures, but the dielectric strength is difficult to evaluate, the numbers obtained being influenced by the strength of the immersion fluid. For use with superconductors, the insulators with the best properties between 4.2°K and 20°K are mylar, teflon, teflon FEP, and kapton. Studies were made with ac and dc voltages, in liquid nitrogen and He as well as gaseous N_2 and He, and in vacuum at 10°K; data are tabulated. More precise studies of partial discharges, electrode phenomena, properties of interfaces, and other parametric effects will establish a deeper understanding of the results given. (BBB)

12708 SUPERCONDUCTIVITY OF THE SECOND KIND. Tosser, Andre (Univ. de Tech., Le Havre, France). Rev. Gen. Elec., 77: 470–5(May 1968). (In French).

Disappearance of resistivity below the transition temperature is reviewed briefly. The behavior of superconductors placed in a magnetic field and the reversibility of phenomena such as penetration depth characteristics are studied from the viewpoint of the theory of London. The coherence distance is likewise examined. Above a certain critical value of the magnetic field, superconductivity can disappear. Behavior near return to the normal state from the superconducting state allows distinction between type-I superconductors which exhibit an abrupt return, and type-II which return through a series of intermediate steps—the turbulent states and the region of superficial superconductivity; the latter is described in detail. Type-II superconductors have irreversible behavior characteristics when they are put into a magnetic induction. Critical profiles, variation of induction in the sample as a function of space coordinates, are being studied in an effort to resolve conflict between experiment and theory about the nature of the resistivity phenomena observed in this region. (BBB)

12709 DETERMINATION OF THE ISOTOPE EFFECT IN SUPERCONDUCTING α-URANIUM, STABILIZED γ-URANIUM ALLOYS AND THE COMPOUND U_6Fe, AND A STUDY OF THE SUPERCONDUCTIVITY OF ALLOYS FORMED BETWEEN THE COMPOUNDS U_6Mn, U_6Fe, U_6Co, AND U_6Ni. Hill, Henry Hunter. San Diego, Calif., Univ. of California, 1968. 242p.

Thesis.

The change in superconducting transition temperature T_c produced by variation of isotopic mass (the "isotope effect") was measured for uranium in three situations: 1) in α-uranium, made bulk-superconducting by subjecting pure uranium to 11 kbar pressure, 2) in γ-uranium alloys, stabilized at room temperature by cooling rapidly from high temperatures, and 3) in the intermetallic compound U_6Fe. The uranium mass M was varied by alternately using the isotopes ^{235}U and ^{238}U in the preparation of the samples. Assuming the usual exponential dependence of T_c upon M, the results for the γ-U alloys and for U_6Fe may be expressed as $T_c \propto M^{\alpha}$, $\alpha = -0.52$ and -0.56, respectively, values typical of those found for most non-transition element superconductors. The value of the mass exponent α was found to be $\approx +2$ for α-uranium under pressure, representing the only positive isotope effect known among superconductors and an exponent of unusually large magnitude. The implications of these results for the theory of superconductivity and for uranium itself are discussed. Attention is given to the problems encountered in preparing uranium of sufficiently high purity to ascertain its true superconducting properties. An apparent correlation between the superconducting transition temperature of the compounds U_6X, where X = Mn, Fe, Co, and Ni, and the magnetic nature of the X-elements was studied in detail by preparing alloys between the different U_6X compounds. It is found that T_c of the pseudobinary alloy $U_6(X_i, X_j)$ is approximately proportional to the ferromagnetic saturation moment of the pure-element alloy (X_i, X_j). This result is discussed in conjunction with previously observed correlations between superconductivity and magnetism.

The possibility of remnant magnetic character in the superconducting compounds is considered. T_c for the compound U_6Ni is found to be 0.41 ± 0.02°K. (Disser. Abstr.)

12710 CRITICAL PHENOMENA IN SHEATH SUPERCONDUCTIVITY OF Nb. Ostenson, J. E.; Finnemore, D. K. (Ames Lab., Iowa). Phys. Rev. Lett., 22: 188-90(Feb. 3, 1969).

Very close to the superconducting transition temperature, the ratio of the critical magnetic field for surface superconductivity to the upper critical field for the vortex state, H_{c3}/H_{c2}, falls far below the Saint James–de Gennes factor of 1.7. (auth)

12711 THEORY OF LIQUID ^{4}He AT ZERO TEMPERATURE. Brandow, B. H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 22: 173-6(Feb. 3, 1969).

A linked-cluster expansion for the ground state of a many-boson system is presented which permits an exact treatment of particle conservation without introducing a chemical potential. A program of partial summations designed to permit accurate calculations with realistic He–He potentials is proposed. This theory treats the depletion effect in a fully consistent manner. (auth)

12712 HAFNIUM IS NOT A BULK SUPERCONDUCTOR. Cox, J. E. (Naval Research Lab., Washington D. C. Catholic Univ. of America, Washington, D. C.). Phys. Lett., 28A: 326-7(Dec. 16, 1968).

Magnetic susceptibility measurements performed on fifteen well-characterized samples of hafnium down to 0.015°K indicate that pure hafnium is not a bulk superconductor. (auth)

12713 ENERGY-GAP MEASUREMENT OF NIOBIUM NITRIDE. Komenou, K.; Yamashita, T.; Onodera, Y. (Tohoku Univ., Sendai). Phys. Lett., 28A: 335-6(Dec. 16, 1968).

Using the technique of electron tunneling between superconducting films, the energy gap of NbN was measured. The full limiting value of the energy gap obtained is $2\epsilon_{NbN}(0) = 4.50$ MeV and the value $2\epsilon_{NbN}(0)/kT_c$ is 4.08. (auth)

12714 ON THE VALIDITY OF RECENT PHENOMENOLOGICAL THEORIES OF THE ISING MODEL AND SUPERFLUIDITY. Yeh, R. Hsiang-tao (State Univ. of New York, Buffalo). Phys. Lett., 28A: 345-6(Dec. 16, 1968).

It is shown explicitly that the recent phenomenological theories of Wong (for the Ising model) and Mamaladze (for superfluid) are in conflict with exact theory or with experiment. (auth)

12715 THE CRITICAL PARAMETERS OF THIN TYPE-II SUPERCONDUCTOR CYLINDER COATED WITH NORMAL METAL. Takacs, S. (Inst. of Electrical Engineering, Bratislava). Phys. Lett., 28A: 349-50(Dec. 16, 1968).

The upper critical field, the critical temperature, its decrease after coating and its oscillations with magnetic field are calculated under assumption of flux quantization. The limiting radius for the existence of superconductivity is given. (auth)

12716 A CORE MODEL EXPLAINING HALL EFFECT AND RESISTIVITY IN THE MIXED STATE OF TYPE-II SUPERCONDUCTORS. Weijsenfeld, C. H. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 28A: 362-3(Dec. 16, 1968).

A new vortex core model involving the gap relaxation time and the superconducting electron density is proposed. This model explains the measured resistivities and Hall angles remarkably well. (auth)

12717 CRITICAL TEMPERATURE GRADIENT AND CRITICAL CURRENT DENSITY IN THIN FILMS OF A TYPE-I SUPERCONDUCTOR. Huebener, R. P. (Kernforschungsanlage Juelich, Ger. Argonne National Lab., Ill.). Phys. Lett., 28A: 383-4 (Dec. 16, 1968).

Measurements of the critical temperature gradient and the critical current density in superconducting lead films in a transverse magnetic field indicate that the critical current flows predominantly along the surface of the films and that the critical surface currents contribute only very little to the Lorentz force on a fluxoid. (auth)

12718 Nb TM_{010} MODE CAVITY WITH HIGH ELECTRIC FIELD AND Q_0. Weissman, Ira (Varian Associates, Palo Alto, Calif.); Turneaure, J. P. Appl. Phys. Lett., 13: 390-1(Dec. 1, 1968).

A superconducting Nb TM_{010} mode cavity at 8.5 GHz machined from a single piece of reactor-grade electron-beam-melted Nb to avoid joints had an unloaded Q (Q_0) of 2×10^{10}. After some degradation in the Q_0, which took place as the microwave fields were increased, a high Q_0 of 1×10^9 was obtained at a peak electric field on the cavity surface of 27 MV/m. These results were obtained by using ultrahigh-vacuum firing and chemical polishing of the Nb cavity, and ultrahigh vacuum within the cavity during measurement. The high Q_0 at high electric field demonstrates the usefulness of superconducting Nb cavities for devices such as linear particle accelerators and rf separators. (auth)

12719 A METHOD FOR EVALUATING THE STABILITY AND OPERATING CHARACTERISTICS OF COMPOSITE SUPERCONDUCTORS. Purcell, John R.; Brooks, John M. (to United States Atomic Energy Commission). U. S. Patent 3,428,891. Feb. 18, 1969.

The method comprises passing a variable current through a short sample of the composite superconductor, wherein the superconductor has been made discontinuous, and measuring the voltage drop along the coating of the composite superconductor from one side of the discontinuity. (AEC)

12720 MAGNETIC SHIELDING BY SUPERCONDUCTING Nb-40Zr-10Ti HOLLOW CYLINDERS. Kawabe, Ushio; Doi, Toshio; Kudo, Mitsuhiro (Hitachi Ltd., Tokyo). J. Appl. Phys., 40: 10-14(Jan. 1969).

The magnetic shielding by the heat-treated superconducting Nb–40 at. % Zr–10 at. % Ti hollow cylinder, 5 mm in inner diameter, 9 mm in outer diameter, and 25 mm in length, was investigated at 4.2°K in applied axial magnetic field. The dependence of the magnetic shielding capacity upon the field rate of increase was examined for the samples subjected to the solution treatment at 1100°C for 5 h in vacuum of 10^{-6} torr and to the heat treatment at 700°C for 3, 10, and 100 h after solution treatment. The magnetic shielding capacity of the sample, heat treated at 700°C for 100 h, was over 17.5 kOe as the magnetic field was applied with its rate of increase of 0.45 kOe/min. A possible phenomenological model estimating the maximum or minimum magnetic shielding capacity was developed by assuming that the flux front in the Bean critical state moves isothermally or adiabatically toward the interior of the hollow cylinder. The calculated value agreed well with the measured value for each sample. (auth)

12721 METALLOVEDENIE, FIZIKO-KHIMIYA I METALLOFIZIKA SVERKHPROVODNIKOV. TRUDY II I III SOVESHCHANII PO METALLOVEDENIYU, FIZIKO-KHIMII I METALLOFIZIKE SVERKHPROVODNIKOV. (Metallography, Physical Chemistry, and Physics of Superconductors. Proceedings of the 2nd and 3rd Conference on Metallography, Physical Chemistry, and Physics of Superconductors). Savitskii, E. M. (ed.). Moscow, Izdatel'stvo Nauka, 1967. 188p. (CONF-650583; CONF-660578).

Thirty-six articles are included on the properties and structure of superconducting alloys of Nb–Zr, Nb–Ti, V–Ti, Nb–Sn, and Nb–Hf. The influence of impurities on the superconducting properties of Nb–Zr base alloys is discussed. The effects of thermal treatment on the transition temperatures and critical currents of the alloys are analyzed. Constitution diagrams for the above alloys are given and discussed. Superconducting properties of Nb–Sn, Nb–Ga, Nb–Ge, V–Ga, V–Si, and diffusion properties of In, Cd, Pb, Tl, Bi, and Zn in V are also discussed. (R.V.J.)

12722 TUNNELING AND RESISTIVE DETERMINATIONS OF THE TRANSITION TEMPERATURE OF THIN LEAD FILMS. Feldmann, W. L.; Rowell, J. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 40: 312-14(Jan. 1969).

The transition temperature T_c of a lead film has been determined from both the resistance along the film and from tunnel measurements of an aluminum–aluminum-oxide–lead junction. T_c by resistivity was 7.214°K and from tunneling 7.208°K. The agreement indicates that tunneling measurements may be used for accurate determinations of the transition temperature. (auth)

12723 ANISOTROPIC PINNING AND GUIDED MOTION OF VORTICES IN TYPE-II SUPERCONDUCTORS. Niessen, A. K.; Weijsenfeld, C. H. (Philips Research Labs., Eindhoven, Netherlands). J. Appl. Phys., 40: 384-93(Jan. 1969).

Guided motion of vortices in type-II superconductors is studied by measuring transverse voltages. The experiments were performed mainly on a Nb–Ta alloy for various magnetic fields, transport currents, and temperatures. The experiments show that in general, the onset of apparent resistance in the mixed state is coupled with fully guided motion of the vortices. With increasing magnetic field, the ratio of transverse and longitudinal voltages decreases. However, this ratio goes through a maximum in materials where the apparent resistivity goes through a minimum. A model is discussed with a guiding force becoming independent of current at higher current densities. The voltages calculated with this model are in agreement with those measured on a Nb–Ta alloy and on a Pb–In alloy. The model is also applied to the situation where a true Hall effect is measured. The conclusion is that pinning and guiding can reduce the Hall angle when the current density is small. The large Hall angles measured in the mixed state cannot be related to guided motion with the existing models of flux flow. (auth)

12724 CONDUCTIVITY OF SUPERCONDUCTING TIN FILMS AT 20 GHz. D'Aiello, R. V. (RCA Labs., Princeton, N. J.); Freedman, S. J. J. Appl. Phys., 40: 443-4(Jan. 1969).

The linear conductivity of thin (~150 to 400 Å) superconducting tin films was studied, using 20-GHz microwaves in transmission-type experiments. These experiments, undertaken to examine in detail the microwave conductivity of pure tin films, showed excellent agreement with the Mattis–Bardeen theory. (M.H.R.)

12725 T^4 LAW FOR THE DENSITY OF THE NORMAL COMPONENT IN BOSE LIQUIDS. Kehr, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Physica, 33: 620-42(1967).

The density of the normal component of an interacting Bose liquid is evaluated in the limit of low temperatures using the representation of the thermodynamic grand potential as a functional of the temperature-dependent Green's functions. It is shown that the density of the normal component vanishes at absolute zero. For low temperatures the T^4 law of Landau's semiphenomenological theory is derived without any corrections. The elementary excitations with imposed drift velocity are calculated for small energies and momenta as the poles of the Green's two-point functions at absolute zero. These poles yield a phonon spectrum modified according to the imposed drift velocity. (auth)

12726 EXPERIMENTAL DETERMINATION OF THE PARAMETERS OF SUPERCONDUCTIVITY FROM MAGNETIZATION MEASUREMENTS FOR SOME β-TUNGSTEN COMPOUNDS. Meyer, Gundolf (Univ., Giessen, Ger.). Z. Phys., 219: 397-410(1969). (In German).

A complete analysis of magnetization curves is given for bulk sintered samples of Nb_3Sn with low hysteresis and for finely powdered sintered and melted samples of Nb_3Sn, Nb_3Al, V_3Si, and V_3Ga. The Ginzburg–Landau parameter κ and the penetration depth λ of weak magnetic fields is calculated from the temperature dependence of the thermodynamic and upper critical fields H_c and H_{c2}. The slope of the $H_c - T$ curve is about 360 Oe/°K and approximately the same for all measured samples. There is an extremely high increase of the lower critical field H_{c1} if the grain size approaches λ. The occurrence of field expulsion and partially reversible magnetization curves of sintered Nb_3Sn samples with high sintering temperatures and high pore volumes is explained by means of connections between single grains which have lower transition temperatures. (auth)

12727 CLASSICAL SPINS IN SUPERCONDUCTORS. Shiba, Hiroyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 435-51(Sept. 1968).

It is shown that there exists a localized excited state in the energy gap in a superconductor with a classical spin. At finite concentration, localized excited states around classical spins form an "impurity band." The process of growth of the "impurity band" and its effects on observable quantities are investigated. (auth)

12728 HYDRODYNAMIC THEORY OF EXCITATIONS IN SUPERFLUID HELIUM. Widom, Allan. Ithaca, N. Y., Cornell Univ., 1968. 79p.

Thesis.

A hydrodynamic theory of excitations in superfluid helium is proposed. The resulting excitation spectra are related to the true energy spectrum by rigorous inequalities. Numerical calculations are based on neutron scattering data and on the Dalgarno–Lewis variational method. The conclusion of the numerical work is that the proposed theory produces an excitation spectrum which is at least as accurate as the Feynman–Cohen spectrum. The analogous form for the spectrum of ^{3}He impurities is rigorously exact. This follows from a new effective mass sum rule which is the impurity analog of the well-known compressibility sum rule for pure liquid ^{4}He. (Disser. Abstr.)

12729 SUPERCURRENTS IN LEAD/COPPER/LEAD SANDWICHES. Clarke, J. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 308: 447-71(Jan. 28, 1969).

The resistance of thin-film lead/copper/lead junctions was studied with the lead in the superconducting state. The junctions will sustain a supercurrent up to a certain critical value above which a voltage appears, rising smoothly from zero as the current is increased. The effect of a magnetic field upon the critical current demonstrated that the sandwiches behave phenomenologically as Josephson junctions. The critical current rises rapidly as the temperature is lowered, decreases exponentially with increasing thickness of copper, and increases with increase of the mean free path of the copper. A simplified version of the de Gennes theory of the proximity effect was used to account quantitatively for this behavior. The experiments show that the coherence length of the paired electrons in the copper increases as the temperature decreases, implying that thermal fluctuations govern the decay of the pairs. From the value of the decay length, the interaction parameter in copper is estimated to lie between +0.06 and +0.14. The properties of these junctions are compared with those of junctions with insulating barriers. (auth) (UK)

12730 MAGNETIC PROPERTIES OF SUPERCONDUCTORS STUDIED BY NEUTRON DEPOLARIZATION. Weber, H. W.; Rauch, H. (Oesterreichische Hochschule, Vienna). Z. Phys., 219: 482-500(1969).

A new method is described which allows the study of the magnetic properties of superconductors. Measurements on various niobium and lead samples were taken to study the influence of surface conditions and lattice defects on the formation of the mixed and intermediate states. A strong dependence of flux penetration on surface conditions is found. Above H_{c1} the results indicate the formation of a disturbed flux line lattice. The influence of external fields present when the superconductor is cooled through T_c is discussed and evidence for the intermediate state of type-II superconductors is presented. Finally, a simple model is used to evaluate the mean angle of deviation from the ideal lattice. (auth)

12731 SOME PROBLEMS CONCERNING THE T_c DEPRESSION OF NON-TRANSITION ELEMENT SUPERCONDUCTORS DOPED WITH 3d-TRANSITION ELEMENT IMPURITIES. Wassermann, Eberhard (Physikalisches Institut, Aachen). Z. Phys., 220: 6-28(1969).

A critical discussion of the measurements of the T_c depression of superconductors doped with 3d-element impurities is given under metallurgical aspects. Particularly, the formation of binary solid solutions in these systems is investigated. The contradictions between thin film and bulk material work are removed by showing that metallurgical difficulties connected with the sample preparation have led to incorrect interpretation of the results. Further on, it is shown that an exact proof of the Abrikosov–Gorkov theoretical dependence of the critical temperature versus concentration has so far not been given. (auth)

12732 TRANSPORT PROPERTIES OF THE TYPE-II SUPERCONDUCTORS NIOBIUM AND VANADIUM. Flory, Anthony Thomas. New Brunswick, N. J., Rutgers–The State Univ., 1968. 151p.

Thesis.

The electrical resistance, thermal conductivity, and Hall, Ettingshausen and Peltier effects were measured in several specimens as functions of an applied magnetic field and temperature. In the mixed state, the voltages and reversible heat currents in these specimens are associated with the motion of the vortex structure of type-II superconductors, driven by the presence of an electric transport current. In a high-purity niobium specimen, it was found that vortex pinning strongly influenced the measured voltages and showed that the differential longitudinal and Hall resistivities at large transport currents were insensitive to pinning. Defined this way, both resistivities were found to be proportional to the magnetic induction in the specimen throughout the mixed state. Their ratio, the tangent of the Hall angle in the absence of pinning, was constant in the mixed state. In the region near the upper critical magnetic field, H_{c2}, the longitudinal resistance disagrees with the recent microscopic theory of Caroli and Maki by several orders of magnitude, for all temperatures studied, whereas the behavior of the Hall resistivity is correctly predicted by that theory. There is agreement with the hydrodynamic theories of Bardeen and Stephen and of Nozières and Vinen for the longitudinal resistance. The Hall resistivity and Hall angle agree with the latter theory, but to be consistent with the former, it is necessary to take the magnetic field in the vortex core equal to H_{c2}. In the moderate purity specimens, the vortices carried a large Ettingshausen heat current in their direction of motion. For magnetic fields near H_{c2}, formal agreement with the microscopic theory was found, in that the heat current was proportional to the product of the magnetization and the electric field. However, the magnitude of this effect approached zero at T = 0°K, in serious disagreement with the theory, which predicts a nonzero limiting value. For the high purity niobium specimen, it was shown that both the Peltier and Ettingshausen heat currents contain a significant contribution proportional to the flow of normal electric current. But the observed vortex component in the region near H_{c2} was over an order of magnitude larger than the theoretical value, in the temperature range studied. The thermal conductivity dropped rapidly as the specimen passed from the normal state into the mixed state, and the change in thermal conductivity was proportional to $\sqrt{H_{c2}-H}$ for fields near H_{c2}. This result is in good agreement with Maki's calculation in the pure limit. It was also found that the phenomenological models of heat transport by isolated vortices agrees with the zero magnetic field extrapolation of the data only at sufficiently low temperature. This corresponds to $T \lesssim 0.7T_c$ in the moderate purity specimens, and $T \lesssim 0.95T_c$ in the high purity specimen. (Disser. Abstr.)

12733 FAR-INFRARED ABSORPTION IN SUPERCONDUCTING AND NORMAL Pb. Drew, Howard Dennis. Ithaca, N. Y., Cornell Univ., 1968. 151p.

Thesis.

The far-infrared surface resistance of Pb in both the superconducting and normal states has been measured using several new experimental techniques. Some surface-resistance data on Sn, Ta, and Nb are also presented. A novel sample geometry was used in which the metal in the form of a ribbon, together with polyethylene ribbon was wound into a transmission-line configuration with a spiral cross section. This sample geometry has the advantages of permitting simple transmission ratio measurements with the detector in a position far removed from the sample and giving a rise to an optimal modulation of the incident radiation. Also, a new ^{3}He bolometer detector was developed for these measurements which was composed on an In and Sb doper germanium cooled to 0.4°K by a ^{3}He evaporator. This bolometer has a NEP of 3×10^{-14} watts and is probably the most sensitive detector of far infrared radiation yet developed. The properties of the transmission line samples and the 0.4°K bolometer are discussed in detail. The transmission line sample geometry permitted the absolute measurement of $R_n - R_s$, the difference in the surface resistances between the superconducting and normal states of the metal. A detailed comparison of the $R_n - R_s$ data could not be made with the BCS theory because structure was observed in the normal state surface resistance which was apparently induced by the magnetic field applied to quench the superconducting state of the metal. However, energy gap measurements were obtained from the transmission line experiments for samples of Pb (4.27 ± 0.05), Sn (3.52 ± 0.30), Ta (3.44 ± 0.08), and Nb (3.72 ± 0.04). These values, which are in units of $2\,\epsilon_g/kT_c$, are in better agreement with tunneling results than previous far infrared measurements. Also, measurements of the slope of the onset of the superconducting state surface resistance, $d(R_s/R_n)/d(\omega/\omega_g)\,|\omega_g$, were obtained from our data which appeared to be in reasonable agreement with the BCS theory. In addition to the transmission-line experiments, a supplemental direct absorption experiment was done on Pb. In this experiment the absorption of radiation in a superconducting Pb specimen was measured directly by measuring the attendant heating of the sample. From this measurement it was determined that R_s for 99.999% pure Pb is zero at 0.4°K to within 2% of the normal state surface resistance between $\omega_g/2$ and ω_g. This corresponds to a maximum surface resistance of 10^{-5} ohms for superconducting Pb below the energy gap frequency. From this result we conclude that there is no precursor absorption in Pb as had previously been reported. Besides showing that R_s is zero for Pb below the gap frequency, one of the important results of this thesis is the demonstration of the usefulness of the transmission-line sample geometry for obtaining far-infrared surface resistance data on metals. (Disser. Abstr.)

12734 FLUX CREEP IN HARD SUPERCONDUCTORS. Beasley, Malcolm Roy. Ithaca, N. Y., Cornell Univ., 1968. 148p.

Thesis.

Flux creep in the critical state of some typical hard type-II superconductors has been investigated in order to improve the basic understanding of the flux creep process and to assess the usefulness of flux creep measurements as a probe of the basic fluxoid pinning mechanisms. The measurements were made using a very sensitive magnetometer incorporating a superconducting quantum interference device as the flux-sensing component. The details of this system are described, and its general usefulness and limitations are discussed. The observed flux changes showed the logarithmic time dependence characteristic of the flux creep, and the creep rate $d\,\phi/d \log t$ was studied as a function of magnetic history, cold working, specimen size, and to some extent temperature. Departures from the critical state and creep in the superconducting sheath region above H_{c2} were also briefly investigated. Except at low fields, the detailed results were found to be in agreement with the behavior expected on the basis of the Anderson–Kim flux creep theory and to provide quantitative results for the material sensitive parameters of the theory (i.e., the pinning energy and the activation volume or flux bundle size). The measured pinning energies were found to be consistent with published estimates of the pinning properties of dislocations and indicate that each flux bundle interacts with many dislocations. (Diss. Abstr.)

12735 SUPERCONDUCTIVITY IN THIN FILMS OF BERYLLIUM. Curzon, A. E.; Mascall, A. J. (Imperial Coll. of Science and Tech., London). J. Phys., C (London), 2: 383-6(Feb. 1969).

A thin film of beryllium evaporated in an electron diffraction camera, at liquid-helium temperatures, was examined as to its structure and for superconductivity — the former by reflexion diffraction, the latter by the "electron shadow" method. It was found that the film was superconducting below about 7°K, and that the structure was "amorphous". The same film after annealing at room temperature gave the normal hexagonal diffraction pattern; in this state it was not superconducting at the lowest temperature used (4.2°K). (auth) (UK)

12736 CONTRIBUTION OF THE SURFACE TO THE CURRENT-CARRYING CAPACITY OF TYPE-II SUPERCONDUCTORS IN THE MIXED STATE. Lowell, J. (Oxford Univ.). J. Phys., C (London), 2: 372-83(Feb. 1969).

Experiments on type-II superconductors of low defect density revealed that the current-carrying capacity in the mixed state is profoundly influenced by any plane surface parallel to the magnetic field direction. Similar surface effects are found to be present when the force on the flux lines is due to a temperature gradient rather than to a transport current. A temperature gradient localized near to the surface influences the capacity to support transport current in a manner which varies with the polarity of field and current. It is concluded that critical current is controlled by interactions between the fluxoids and the sample surface, and not by a "resistanceless surface layer". Crude calculations based on the interaction model provide qualitative explanations of polarity effects in the critical current and of the presence of a strong minimum in the critical current of one polarity. (auth) (UK)

Plasma and Thermonuclear Physics

12737 (RFP-Trans-44) VAPOR JETS OF ELECTRODE MATERIALS DURING A BRIEF HIGH-INTENSITY ELECTRICAL DISCHARGE (RUSSIAN). Hermoch, Vladimir. Translated from Czech. J. Phys., 9: 221-8(1959). 16p. Dep. CFSTI.

An abstract from the original appeared previously in NSA 14: 5705. (M.O.W.)

12738 ADVANCES IN PLASMA PHYSICS. VOLUME 1. Simon, Albert; Thompson, William B. (eds.). New York, John Wiley and Sons, Inc., 1968. 348p.

Separate abstracts were prepared for the 6 individual sections. (M.O.W.)

For abstracts of individual sections see: 12607, 12673, 12853, 12886, 12927, and 12928.

Confinement and Heating

12739 (AEC-tr-7007) PLASMA-ELECTRON CONFINEMENT REGION FOR ELECTRON-CYCLOTRON RESONANCE IN A MAGNETIC TRAP WITH PLUGS. Galaktionov, B. V.; D'yachenko, V. V.; Novik, K. M.; Piliya, A. D. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report NP-17565. 6p. Dep. CFSTI.

An abstract for the original paper appeared earlier as NSA 22: 44075. (M.O.W.)

12740 (N-68-30811) HIGH-TEMPERATURE ENERGY SYSTEMS WITH PLASMA REACTORS AND INDUCTIVE MAGNETOPLASMADYNAMIC CONVERTORS. Peschka, W. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt E. V., Porz (West Germany). Institut fuer Energiewandlung und Elektrische Antriebe). Translated from report DLR-FB-67-59. 14p. CFSTI.

Possible future power generating equipment which operates with high-temperature plasma as a working medium and, subsequently, with high power density is described. This temperature range requires reactors whose nuclear fuel is in the plasma state (fission or fusion reactors) coupled to magnetoplasmadynamic generators acting as energy converters. Electrodeless MPD generators with all their advantages can be successfully employed. The technological ramifications arising from the application of these high temperatures with respect to the reactors and the MPD generators as well as to the heat release equipment are discussed. (auth)

12741 (NP-17743) ON ONE METHOD OF EXTERNAL ELECTRON INJECTION INTO CLOSED TOROIDAL SYSTEMS. Preprint No. 178. Andryukhina, E. D.; Fedyanin, O. I.; Khol'nov, Yu. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 10p. (In Russian). Dep.

A method is suggested for electron injection into a confined (in relation to the injector) magnetic surface using a pulsed transverse magnetic field. A magnetic trap was designed, consisting of a stellarator with a double-entrance helical field which varied from 1 to 20 kOe with half-cycle lifetime T/2 = 18 to 40 msec.

Coverage of the magnetic surface along the cross section diametrically opposite the injection point was measured with a 10 × 30 mm plane probe that was shifted along the toroidal radius and the vertical. In case of electron injection into the helical magnetic field, the electrons covered the surface closed in relation to the magnetic surface of the injector. The graphical data are also given on the magnetic surface during electron beam injection into the stellarator field at $\Sigma = 0.175$ (the ratio of helical magnetic field harmonics to the longitudinal component). Data obtained show that the method enables investigations of the magnetic surface and the lifetime of electrons, exclusive of the influence of construction components of the electron gun. (R.V.J.)

12742 NONEXISTENCE OF TOROIDAL PLASMA EQUILIBRIUM IN RING DEVICES WITH CONVENTIONAL SUPPORTS. **Yoshikawa, S. (Princeton Univ., N. J.). Phys. Fluids, 11: 2777-8(Dec. 1968).**

Multipole plasma confinement devices with conventional magnetically shielded supports do not possess toroidal equilibria because the devices are no longer topological tori. (auth)

12743 EXPERIMENT IN STOCHASTIC HEATING. **Puri, S.; Dunn, D. A.; Thomassen, K. I. (Stanford Univ., Calif.). Phys. Fluids, 11: 2728-32(Dec. 1968).**

A collisionless plasma in a magnetic mirror is heated by a random electric field, acting transverse to the magnetic field. Heating occurs when the noise spectrum spans the band of electron cyclotron frequencies existing in the mirror. The electron heating rate, $1.0 \times 10^5 \langle E^2(V/cm)^2\rangle$ eV/sec, is in reasonable agreement with the value predicted by a simplified theoretical analysis. (auth)

12744 NUMERICAL STUDIES OF TURBULENT HEATING. **Gary, S. Peter; Montgomery, David (Univ. of Iowa, Iowa City). Phys. Fluids, 11: 2733-7(Dec. 1968).**

The equations of motion of electrons subject to different combinations of electrostatic waves were integrated numerically. Magnetic fields were ignored throughout. For particular choices of wave amplitude, wave number, frequency, and phase, and for given initial velocities, the mean-square velocity spreading of a collection of particles subject to three different kinds of wave spectra is calculated: (a) a single monochromatic wave; (b) several (up to 10) monochromatic waves with differing phase velocities; and (c) a single wave with a random phase change at regular intervals. Heating occurs due to two basic effects: the "trapping" of particles, operative in all three spectra, and the spreading of the spectral density due to the random phase interruptions in (c). For the parameters chosen, numerical results are that the most efficient heating occurs in case (c). (auth)

12745 DIFFUSION OF FAST ELECTRONS IN STOCHASTIC MAGNETIC FIELDS. **Massel, G. A. (Langley Research Center, Hampton, Va.); Feix, M. R. Phys. Fluids, 11: 2738-40(Dec. 1968).**

The diffusion of fast electrons in a stochastic magnetic field is considered for the simple case of the fluctuating field parallel to the steady field. The assumption defining the fast electrons is that their particle velocity is greater than the phase velocity characteristic of the fluctuating field. In the limit of observation times greater than both the Larmor period and the correlation time of the stochastic field, the diffusion coefficient can be obtained explicitly as a function of the ratio of the correlation time to the Larmor period and the result holds for all values of the ratio of these characteristic times. The result and hence the assumptions in the derivation are checked by Monte Carlo calculations. (auth)

12746 CURRENT DECAY IN A STREAMING PLASMA DUE TO WEAK TURBULENCE. **Ossakow, Sidney L. (Lockheed Palo Alto Research Lab., Calif.); Fried, Burton D. Phys. Fluids, 11: 2741-8(Dec. 1968).**

A low-β plasma can stream across a "slab" of magnetic field provided the spatial extent L of the field along the streaming direction is small compared with the geometric mean cyclotron radius and provided the magnetic field is not too strong ($\omega_{ce} \lesssim \omega_{pc}$). The behavior of the plasma which emerges from the magnetic field region is discussed here. On a scale large compared with L, the effect of the magnetic field is simply to impart an impulsive transverse velocity to the electrons of the streaming plasma. If this velocity exceeds the stability limit for the two-stream instability, long-wavelength, longitudinal thermal fluctuations should grow to such an amplitude that the resulting weak turbulence reduces the transverse velocity to zero, the associated kinetic energy being converted to electron thermal energy. A solution to this problem within the quasi-linear approximation for a "collisionless" plasma is given here, together with numerical calculations of the spatial decay of the current and the associated electron heating. As expected, the length of the turbulent transition region, in which the directed transverse energy is thermalized, is an increasing function of the initial plasma density, but a decreasing function of the initial electron temperature and transverse velocity. A small charge separation ($n_i - n_e \lesssim 10^{-4}\, n_e$) provides an electric field just sufficient to balance the pressure gradient, n dT/dx. (auth)

12747 GUIDING CENTER DRIFTS IN TIME-DEPENDENT MERIDIONAL MAGNETIC FIELDS. **Birmingham, Thomas J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids, 11: 2749-52(Dec. 1968).**

The problem of a particle trapped in a time-dependent meridional magnetic mirror field and at the same time subjected to a time-dependent perpendicular electric field ($E \cdot B = 0$) is considered. Bounce-averaged guiding-center theory is used to derive expressions for the drift velocity components. These drift expressions depend in a straightforward fashion on the structures of the magnetic and electric fields and on the particle charge, kinetic energy, longitudinal invariant, and bounce period. In the special case of a static magnetic field, no electric field, and $J = 0$ particles, the drift equations are integrated and the bounce-averaged guiding-center trajectory obtained. (auth)

12748 NONLINEAR THEORY OF PLASMA HEATING BY hf FIELDS IN CONDITIONS OF CYCLOTRON RESONANCE. **Krasovitskii, V. B. At. Energ. (USSR), 26: 43-6(Jan. 1969). (In Russian).**

The problem of the magnetoactive plasma stability, when the plasma is in the hf field and the field frequency is almost equal to the plasma own frequency, is considered in approximation to the self-coordinated field. The conditions of the system instability are determined and the maximum energy obtained by plasma particles under these conditions is defined. (auth)

12749 PROGRESS TOWARDS A NUCLEAR FUSION REACTOR. **Adams, J. B. (United Kingdom Atomic Energy Authority, London). Contemp. Phys., 10: 1-20(Jan. 1969).**

The physical conditions under which nuclear fusion reactions are most likely to be sustained are outlined, pointing out the sharp difference between the plasma state of matter necessary for nuclear fusion reactions and the thermodynamically more relaxed conditions sufficient for nuclear fission reactions. The confinement of hot dense plasmas by magnetic fields is the principal scientific problem to be solved, and progress in this work under the main headings of open-ended magnetic confinement systems and closed magnetic confinement systems is described. The technological problems of nuclear fusion reactors, which are the next major obstacles to be overcome once the confinement problem is solved, and the economic possibilities of these reactors as electricity power producers, are also reviewed. (auth) (UK)

12750 INJECTION OF A PLASMA INTO A CLOSED MAGNETIC TRAP WITH A DOUBLE-HELIX FIELD. **Batanov, G. M.; Grebenshchikov, S. E.; Ivanovskii, M. A.; Sbitnikova, I. S.; Fedyanin, G. I. pp 7-19 of Fizika Plazmy. Moscow, Nauka Press, 1966. (In Russian).**

In the experimental study of various plasma-injection approaches, the methods discussed include (1) injection into a programmed magnetic field, (2) injection along a cluster of magnetic-field lines of force expanded outside the magnetic-field perimeter, and (3) injection by colliding plasma fluxes in the transverse magnetic field of a toroidal trap. Strong effects of a helical external magnetic field on the plasma containment time, density, and distribution over the trap cross section are established. It is believed that effective plasma injection into closed magnetic systems can be achieved when these methods are developed further. (auth) (STAR)

12751 COMPUTER DESCRIPTION OF THE C-STELLARATOR OHMIC HEATING DISCHARGES IN HYDROGEN. **Hinnov, E.; Bishop, A. S.; Fallon, H. Jr. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Plasma Phys., 10: 291-307(1967). (MATT-527).**

The behavior of the ohmic heating discharges of hydrogen in the C-stellarator has been computed for a range of input parameters: ohmic heating currents, confining fields, initial gas densities, and recycling rates. The calculations were performed on a 7094 computer, by solving a set of coupled equations expressing particle densities, temperatures, emission of atomic and molecular light, etc., as functions of time in terms of known rate coefficients for ionization, excitation, dissociation, and charge exchange, and known relationships between electron temperature and the electrical conductivity, the particle loss rate, and the electron–ion collision rate. The calculated quantities are in reasonably good agreement with experimental data over the available range of parameters. The results show inter alia, that it is immaterial (except for the emitted light) whether the starting gas, or the recycling, consists of 2H or H_2; the ion temperature achieved in the ohmic heating discharges are remarkably independent of the input parameters, and will not exceed ~30 eV in a plasma of 5-cm radius at 36 kG. Extending the calculations to larger confining fields and discharge radii does not result in very substantial increase in particle temperature, without changing the assumed linear temperature dependence of the loss rate. (auth)

12752 ELECTRON HEATING BY BEAM–PLASMA INTERACTION IN UNIFORM MAGNETIC FIELD. Jancarik, J.; Piffl, V.; Seidl, M. (Inst. of Plasma Physics, Prague). Phys. Lett., 28A: 331-2(Dec. 16, 1968).

Experimental evidence is given for the enhancement of rf electron heating by cyclotron resonance absorption in a cylindrical layer where the frequency of the rf field excited by electron beam–plasma interaction is equal to the local hybrid frequency. (auth)

12753 POLYNOMIAL REPRESENTATIONS OF MIRROR-CUSP FIELDS. Faulkner, J. E. (Aerojet-General Corp., San Ramon, Calif.). Nucl. Fusion, 8: 356-60(Dec. 1968).

Fields produced by the combination of mirror coils and Ioffe (multipole) bars are of interest in controlled fusion research because they are adiabatic magnetic wells. In an attempt to represent analytically these mirror-cusp fields, rules were devised to generate field vectors with the following properties: (1) the Cartesian components of each vector are homogeneous polynomials in the Cartesian coordinates; (2) each vector satisfies Maxwell's equations for a static, vacuum magnetic field; (3) each vector has either the same symmetry as a field produced by mirror coils or the same symmetry as a field produced by Ioffe bars. The results are presented. (M.O.W.)

12754 PHASE METHOD FOR MEASURING THE TIME OF ION MOTION IN THEIR OWN GASES ACROSS A MAGNETIC FIELD. Pasečhnik, L. L.; Yagola, V. V. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 1564-6(Sept. 1968). (In Russian).

The phase method suggested for measuring the time of ion motion in gases across a magnetic field is based on the measurements of the phase shift between the moment of ion generation and the moment of its migration into the collector placed at a certain distance from the point of ionization. The order of error of the method is less than 5% and it can be used for measuring diffusion and motion of charged particles and diffusion in plasma. The design and performance of the experimental apparatus are included. (R.V.J.)

12755 INVESTIGATION OF TRANSVERSE PLASMA INJECTION INTO A TOROIDAL MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 968-74(June 1968). (In Russian).

The injection and confinement of a hydrogen plasma in a toroidal magnetic field generated by a line current are investigated experimentally. The plasma is injected from a conical source, through a stainless steel conductor, across the toroidal magnetic field. The plasma pulse enters the vacuum chamber (where the field is located) with a velocity of 3.4×10^6 cm/sec and a density of 10^{14} cm^{-3}. Its confinement is measured by means of a Langmuir probe and a plasmascope, both being capable of traversing radially and azimuthally in the field. The results of the measurements are shown graphically. As the magnetic field strength is increased, the plasma velocity decreases monotonically and the density of the confined plasma increases. The results also show that the confined plasma conserves the polarized electric field. Various density profiles are obtained for the confined plasma as a function of the radial and azimuthal location in the field. (ATD)

12756 THE INFLUENCE OF TRANSVERSE MAGNETIC FIELD ON THE TOROIDAL DISCHARGE IN THE TUMAN MACHINE. Kaganskii, M. G.; Ovsyannikov, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 1043-9(July 1968). (In Russian).

The effects of transverse magnetic fields on toroidal discharge are studied in the Tuman device. It is found that the transverse field is 1% of the primary longitudinal component of the magnetic field. Measurements clearly indicate that the relative directions of the electric and magnetic fields are critical and that "barrier-layer conductivity" is caused by the transverse component of the magnetic field. The magnetic field is subsequently modified by introducing auxiliary fields. The amplitude of the discharge current is found to be independent of the transverse magnetic field strength at pressures of 2×10^{-2} mm Hg, but it varies strongly for lower pressures. An optimum transverse field is then found which tends to enhance the electric conductivity and decrease the limiting pressure where the toroidal discharge takes place, from 4×10^{-3} to 8×10^{-4}. (ATD)

12757 VACUUM SYSTEM OF THE STELLARATOR SIRIUS. Volkov, E. D.; Kozlov, V. N.; Kruglov, S. A.; Lunev, V. M.; Nikolaev, R. M.; Romanov, A. A.; Sablev, L. P. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 38: 979-85(June 1968). (In Russian).

The vacuum system for the Sirius stellarator is described, and a schematic diagram of the system is shown. The necessity of a "high-purity" vacuum system in thermonuclear research is also discussed. The construction and operation of the vacuum system are given in detail. After several outgassing cycles with preheating to 400 to 450 C, a vacuum of 4×10^{-10} mm Hg in a volume of 100 l was obtained. (ATD)

12758 THEORETICAL LIMITATIONS TO THE HALL ACCELERATION MECHANISM IN THE POLYTRON MACHINE. Dunnett, R. M. (Imperial Coll. of Science and Tech., London. London Univ.). Nucl. Fusion, 8: 287-95(Dec. 1968).

In the "polytron" a series of cusp magnetic fields is superimposed on a toroidal discharge. Stability is improved by favorable field curvature, and containment will be good if the plasma acquires a substantial velocity relative to the cusps. This can be achieved by a Hall acceleration mechanism. A hydromagnetic analysis is presented in which realistic time variations of electric and magnetic fields are allowed, and plasma self-fields are included. An upper bound is set to the acceleration obtainable from a given cusp system and expressed as a critical electric field E_c. The existence of E_c is confirmed experimentally, and it is possible to reproduce experimental waveforms approximately by inserting appropriate parameters into the equations. The effect of a toroidal magnetic field is also considered and a criterion derived for its maximum permissible value. In designing a fusion device this criterion could be an important consideration. (auth)

12759 CLOSED EXPRESSIONS FOR THE MAGNETIC FIELD IN TWO-DIMENSIONAL MULTIPOLE CONFIGURATIONS. Boris, J. P.; Kuckes, A. F. (Princeton Univ., N. J.). Nucl. Fusion, 8: 323-8(Dec. 1968).

Closed analytic expressions for the vector potential and the magnetic field generated by axisymmetric multipole line currents are presented. These results complement and simplify earlier work utilizing truncated infinite series. The infinite series, which arise by Fourier analyzing the angular dependence of the current distribution, are summed explicitly. For the special case of filamentary line conductors the vector potential, as well as the field components, can be summed. For this case explicit equations for the lines of force and magnetic isobars can be determined. One finds that all lines of force penetrating a cylinder whose radius is determined explicitly by the order of the multipole take on the maximum value of $|\vec{B}|$ on that cylinder. Thus, for a low-density plasma composed of adiabatically gyrating charged particles, the region of possible plasma containment within the region bounded by the fixed conductors is a cylinder of circular cross section with known radius. (auth)

12760 REGION OF PLASMA ELECTRON CONFINEMENT AT ELECTRON CYCLOTRON RESONANCE IN MAGNETIC MIRROR SYSTEM. Galaktionov, B. V.; D'yachenko, V. V.; Novik, K. M.; Piliya, A. D. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 38: 1102-5(June 1968). (In Russian).

It has been theoretically shown earlier that in magnetic mirror machines with ultra-high-frequency heating of plasma, all the electrons are reflected from the magnetic mirrors in one plane where the electron-cyclotron resonance is satisfied. This work investigates experimentally the region of reflection of electrons in such machines. Two machines were used in this study. The dimensions and operating regimes are given (magnetic field risetime of about 0.5×10^{-6} sec, uhf generator operated at 9350 MHz at 20 kW for 4×10^{-6} sec). The resonance region was positioned by adjusting the magnetic field amplitude. The position of resonance with reference to the central plane of the system was determined by magnetic probes. It was studied in plasma with a density of 5×10^{11} cm^{-3} and electron temperature of 2000 eV and plasma of 1.5×10^{12} cm^{-3} and a temperature of about 250 eV. The results show that a narrow region does exist in the plasma at a position qualitatively predicted by the theory where the electron reflection takes place. (ATD)

Diagnostics

Refer also to abstract 12866.

12761 (CEA-CONF-1115) SCATTERING OF E.M. WAVE BY A PLASMA. Nguyen T. K; Nakack (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 10p. (CONF-680831-3). Dep.

From Conference on Plasma Diagnosis, Culham, England. Handwritten MS Copy.

A microwave apparatus for use in plasma diagnostics is described. Scattering spectra are given for hydrogen and helium plasmas. (M.O.W.)

12762 (IAE-1601) MEASURING PLASMA ENERGY USING THE TOKAMAK-3 APPARATUS. Mirnov, S. V. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 32p. (In Russian). Dep.

The work is devoted to the measurement of the total plasma energy (E) using the Tokamak-3 apparatus. The transverse energy component ($E_\perp$) was determined by the magnitude of diamagnetic effect of the plasma and the longitudinal component ($E_{||}$) by the magnitude of equilibrium displacement of the plasma cord. It was shown that in the range of the accuracy of the experiment it may be considered that $E = E_\perp + E_{||} = {}^3/_2 E$. Thus, the problem of the determination of E was reduced to the problem of the determination of $E_\perp$. The diamagnetic flux corresponding to the assumed value of $E_\perp$ was measured against the background of a paramagnetic and a quasi-constant magnetic fluxes which exceeded it by 10 and 10^4 times. This circumstance put very rigid requirements in regard to the measurement system making necessary a detailed analysis of its elements and performance of additional calibration experiments. An evaluation of the accuracy of the measurements has been carried out and the curves of the relationship of the values of E obtained to the parameters of the discharge are given. (JPRS)

12763 (NP-17749) CALORIMETRIC MEASUREMENT OF ULTRA-HIGH-FREQUENCY POWER. Preprint No. 136. Tsopp, L. E. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 14p. (In Russian). Dep.

Descriptions are given of a circulating calorimeter used with the Ramus-II installation, designed for studying radiative acceleration of plasma. The calorimeter is capable of measuring the mean power from 10 to 200 W, with an accuracy of ±5%, at pulsed power exceeding 1 MW. Alcohol is used as the thermometric liquid with a sensitive thermopile enabling calibration according to dc power. (R.V.J.)

12764 (NRL-6738) DETERMINATION OF ELECTRON TEMPERATURES BETWEEN 50 eV AND 100 keV FROM X-RAY CONTINUUM RADIATION IN PLASMAS. Elton, R. C. (Naval Research Lab., Washington, D. C.). Apr. 18, 1968. 70p.

Previous calculations of the total integrated bremsstrahlung radiation passing through absorbing foils of beryllium, aluminum, and nickel (as well as aluminum and nickel in combination with carbon (polyethylene)) are included and extended to cover temperatures equivalent to an energy range from 50 eV to 100 keV and to include gold. Such information is necessary in obtaining values for the electron temperature in a plasma from measurements of the soft x-ray continuum emission. The spectral distribution of the transmitted continuum radiation is presented over the entire temperature range, for use in determining the most suitable spectral region. (auth)

12765 TEMPERATURE MEASUREMENTS FOR DIAGNOSTICS OF PLASMAS PRODUCED AND HEATED BY LASER PULSES. Boegershausen, W.; Hoenle, K. (Technische Hochschule, Munich). Spectrochim. Acta, Part B, 24: 71-83(Jan. 1969). (In German).

The elements Fe, W, Zn, and C were vaporized by irradiation with focused laser beams. The power was 2 kW for normal-pulse and 1 MW for giant-pulse operation. Different methods of temperature measurement for the plasmas were used, and temperatures from 6000 to 29,000°K were measured. The population of the energy levels in the optically thin plasmas satisfied Boltzmann statistics according to excitation temperatures between 6000 and 8000°K, while the degree of ionization indicated a considerably higher temperature. (auth) (UK)

12766 COMPARISON OF 35-GHz MICROWAVE REFLECTION PROBE METHOD WITH 150-GHz MICROWAVE INTERFEROMETRY. Okamoto, Yukio; Fujita, Junji (Nagoya Univ., Japan). Jap. J. Appl. Phys., 8: 281(1969).

The electron density determined from a 35-GHz microwave reflection probe, which is modified to cover the range below cutoff density, is compared with that from a 150-GHz microwave interferometer and Langmuir probe on a BSG device (density ~10^{15} cm^{-3}, flow velocity ~10^6 cm sec^{-1}). (M.O.W.)

12767 MEASUREMENTS OF SLOW THETA-PINCH PLASMA BY MACH-ZEHNDER INTERFEROMETER WITH GIANT PULSE RUBY LASER. Hayase, Kiyoshi (Nagoya Univ., Japan); Miyamoto, Kenro; Uchida, Taijiro. Jap. J. Appl. Phys., 8: 273(1969).

A Mach-Zehnder interferometer with a few-megawatt giant pulse ruby laser is applied to study slow theta-pinch plasma that is used as a plasma source of a BSG device. The slow theta-pinch plasma is produced by condenser discharge of 11 kJ, capacitor bank charged up to 40 kV into 12-turn coil. Used gas is helium and the plasma is produced at the third half-cycle. The start of the theta-pinch device is synchronized with the mirror rotation of the Q-switch laser within an accuracy of 0.5 μs. The axially integrated electron density is given by 3.2×10^{17} $F(r,\theta)$ cm^{-2}, where $F(r,\theta)$ is the number of fringe shift of the interferogram and depends on coordinates (r,θ) of plasma cross section. (M.O.W.)

12768 COMPUTER SIMULATION OF THE PLASMA RESONANCE PROBE. Hellberg, M. A. (Univ. of Natal, Durban, S. Africa). J. Plasma Phys., 2: 395-435(Aug. 1968).

A numerical experiment is described in which a one-dimensional plasma model is used to simulate the resonance probe. The trajectories of a large number of plane electron sheets are followed in a self-consistent calculation which takes account of a spatially dependent but smeared-out ion background, and externally applied static and rf potentials. No differentiation between sheath and plasma regions is introduced, nor is there any linearization. The typical resonant rectification curves, with resonance below ω_p, are obtained. A comparison is made between the plasma behavior at resonance and in frequency ranges above and below the resonance. For example, the phase of current collection w.r.t. probe potential is studied. Fourier analysis of potential and density variations is used to obtain further information on phase relationships. Orbit diagrams of electrons forming the current under resonant conditions are presented, and a model for the mechanism of resonant rectification in terms of electrons at the sheath edge put forward. (auth)

12769 MEASUREMENT OF THE RADIO FREQUENCY ADMITTANCE OF A PLANE GRID CAPACITOR IN A PLASMA. Freeston, I. L. (Radio and Space Research Station, Slough, Eng.). J. Plasma Phys., 2: 329-37(Aug. 1968).

The admittance of a plane grid capacitor immersed in an ion beam plasma has been measured, and the results are in general agreement with the kinetic theory of the admittance (Buckley 1968). With a steady-bias potential applied to the grids, the results showed a deviation from the theoretical behavior that is attributable to plasma depletion by the grids. The effect of varying the background pressure showed that electron-neutral collisions had a negligible effect on the measured admittance. A significant change in the admittance was found for a measuring voltage applied to the grids of the order of the electron temperature. (auth)

12770 RADIO FREQUENCY PROPERTIES OF A PLANE GRID CAPACITOR IMMERSED IN A HOT COLLISION-FREE PLASMA. Buckley, R. (Radio and Space Research Station, Slough, Eng.). J. Plasma Phys., 2: 339-51(Aug. 1968).

A pair of plane parallel grids is inserted in a hot plasma, and an oscillatory voltage is applied across them. The electric field excited in the plasma, and the complex admittance of the grid/plasma system, are computed for applied frequencies high enough to justify neglect of ion response. The grids are electrically, but not mechanically, coupled to the plasma, which is assumed to be in a spatially uniform collision-free Maxwellian equilibrium state. The field is computed as a function of distance from the grid plates over a range of frequencies covering the plasma frequency, and the complex admittance of the system is computed as a function of frequency at various grid separation distances. The real component of the field and the capacitive component of the admittance are subject to three major effects: cold plasma dielectric behavior, oscillatory Debye sheaths on the grids, and (above the plasma frequency), longitudinal plasma waves. The imaginary field component and the conductive admittance component are produced by spatial Landau damping. In an accompanying paper (Freeston 1968), the computed admittance is compared with laboratory measurements made in a situation approximating well to the idealized problem considered. (auth)

12771 AN EXPERIMENTAL INVESTIGATION INTO THE BEHAVIOUR OF A SPHERICAL PLASMA RESONANCE PROBE IN A MAGNETIC FIELD. Davies, P. G. (Radio and Space Research Station, Slough, Eng.). J. Plasma Phys., 1: 451-62 (Nov. 1967).

The rectified electron current to a nonmagnetic and to a magnetic spherical plasma probe has been investigated as a function of the frequency of the applied alternating potential, the discharge current in the plasma source, and the magnitude of the magnetic field produced by a Helmholtz coil pair. The frequency at the main peak in the rectified current was found to be always greater than the gyrofrequency and to lie within a range of frequency predicted by Crawford from an analysis of a simplified model. The results of this laboratory work have been applied to a rocket-borne experiment on resonance rectification previously carried out by R.S.R.S. (auth)

12772 CONTINUUM THEORY OF ELECTROSTATIC PROBES IN A SLIGHTLY IONIZED GAS. Toba, K.; Sayano, S. (Douglas Aircraft Co., Santa Monica, Calif.). J. Plasma Phys., 1: 407-23(Nov. 1967).

A systematic continuum theory based on the method of matched asymptotic expansions is developed to deal with electrostatic probes in a slightly ionized gas. To the first approximation of thin space charge sheath, the sheath solution is shown to become common to the geometries considered, i.e., plane, cylindrically and spherically symmetric probe surfaces: the main interest lies in the last geometry. The second-order approximation strongly affects the last two geometries. Detailed numerical calculations are presented to illustrate the effects of a finite ratio of the Debye length to the characteristic body dimension; including a contraction of the sheath region and enhancement of the electric field from the asymptotic (first-order approximation) values. (auth)

12773 THE RESPONSE OF A SPHERICAL PLASMA PROBE TO ALTERNATING POTENTIALS. RESULTS OF COMPUTATIONS AND USE FOR PLASMA DIAGNOSTICS. Buckley, R. (Radio and Space Research Station, Slough, Eng.). J. Plasma Phys., 1: 171-91(May 1967).

In a previous paper, the rf characteristics of a spherical probe immersed in a hot, low-density plasma using a realistic sheath model were considered, and a few results of computations presented. The remainder of these results are given in this paper. The dependences of rf admittance, and rectified current on probe radius, dc bias, and electron neutral collision frequency are exhibited and shown to be qualitatively in accord with the predictions of simple slab-sheath/dielectric models. It is shown how in principle, analysis of resonance rectification characteristics using curves included in the paper can yield values of electron density n_e, temperature T_e, and electron–neutral collision frequency ν. Two methods of reduction are applied to some laboratory results obtained at Slough and are shown to give reasonably consistent values of n_e and ν, but the values of T_e show considerable scatter. These methods could complement the Langmuir probe which gives more reliable values of T_e than of n_e in low-density plasmas with $n_e \lesssim 10^8$ cm^{-3}. Effects of magnetic fields are not included in this paper. (auth)

12774 BOUNDARY-LAYER STRUCTURE IN A SHOCK-GENERATED PLASMA FLOW. PART II. EXPERIMENTS USING A NEW QUANTITATIVE SCHLIEREN TECHNIQUE. Knoeoes, Stellan (Stanford Univ., Calif.). J. Plasma Phys., 2: 243-55(June 1968).

The shock-tube wide-wall boundary layer in a 1-eV, high-density argon plasma was studied experimentally using a new, simple, quantitative schlieren technique. The angular refraction of light which enters the shock-type test section parallel to a side wall and passes through typically 1-mm-thick boundary layers was determined in two separate wavelengths. This was done by measuring the displacements of two shadows formed by two thin wires placed in the point source light, which is reflected noncentrally by a concave spherical mirror. The experiments were of exploratory nature only, but clearly demonstrated the feasibility of the new technique in analyzing plasma-boundary-layer flows. Measured electron density profiles in the high-temperature region of the side-wall boundary layers agreed within experimental errors with those calculated from the equilibrium-boundary-layer theory. (auth)

12775 A METHOD FOR DETERMINATION OF THE PLASMA POTENTIAL BY AN RF PROBE. Dote, Toshihiko (Inst. of Physical and Chemical Research, Tokyo). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 4: 564-78(Oct. 1968). (In Japanese).

A method for measuring the space potential of a plasma by a Langmuir probe is presented. The principle of the method is based upon a behavior of the rf impedance of the plasma-sheath-probe system. The sensitivity of the method may be very high, since the rf characteristics at the space potential are very pronounced. Here, one was able to obtain the space potential of an order of 2 mV in a mercury diffusion plant. (NSA of Japan)

12776 PATH-INTEGRAL CALCULATION OF THE QUANTUM-STATISTICAL DENSITY MATRIX FOR ATTRACTIVE COULOMB FORCES. Storer, R. G. (Flinders Univ., South Australia). J. Math. Phys. (N.Y.), 9: 964-70(June 1968).

A method for the calculation of the two-particle statistical density matrix for attractive Coulomb forces is described. The path-integral expression for the density matrix is reduced to a modified path integral which involves summation over only one-dimensional paths. This expression is then approximated by an iteration procedure using direct numerical quadratures. The results obtained are related directly to the quantum-mechanical radial-distribution function for a plasma at small ion–electron separations. (auth)

12777 SPECTRUM OF LASER EMISSION SCATTERING BY PLASMA AT ATMOSPHERIC PRESSURE. Pyatnitskii, L. N.; Khaustovich, G. P.; Korobkin, V. V. (Krzhizhanovskii Inst. of Power Engineering, USSR). Teplofiz. Vys. Temp., 6: 751-2 (July-Aug. 1968). (In Russian).

An attempt was made to obtain a light scattering spectrum from low-temperature plasma electrons at atmospheric pressure. An argon arc with tungsten electrodes was used as the plasma source. The scattered light was observed at 90° and analyzed, using a double monochromator, photomultiplier, and oscillograph. Experiments were made in order to determine the influence of laser emission on plasma parameters. The curves obtained showed that laser emission produces a negligible effect on plasma. Using a first approximation in Salpeter theory it is possible to calculate electron concentration and temperature according to the satellite maximum $\Delta\lambda$, in relation to the probing emission line and satellite semi-width $\delta\lambda$. Calculations produced the following plasma parameters for $\Delta\lambda = 50$ Å and $\delta\lambda = 20$ Å: $n = 1.03 \times 10^{17}$ cm^{-3} and $T = 14{,}800$°K. (R.V.J.)

12778 MEASUREMENT OF ARC ELECTRON DENSITIES USING A CO_2 LASER. Konjevic, N. (Inst. of Physics, Belgrade); Hearne, K. R. Phys. Lett., 28A: 309-10(Dec. 16, 1968).

The application of a carbon dioxide laser interferometer, 10.6μ, to the measurement of electron density in an arc plasma is described. Results are given for the axial electron density in argon, current range 30 to 90 A. (auth)

12779 MEASUREMENT OF ELECTRON DENSITY OF A PLASMA BY MEANS OF LASER. Korobkin, V. V.; Malyutin, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 38: 1095-1100(July 1968). (In Russian).

A more sensitive procedure of measuring electron density, developed by the authors earlier (Prib. Tekh. Eksp., No. 2, 223 (1967)) has enabled them to measure electron densities smaller by one order of magnitude than heretofore possible. The method consists of determining the intensity of laser light passing through a Fabry–Perot interferometer. The investigated pulsed plasma is produced inside the interferometer cavity. The presence of plasma changes the length of the optical path in the interferometer and hence the intensity of the light transmitted through the interferometer. The electron density is determined from the change in the light intensity. The density range that can be measured by this method is 10^{11} to 10^{14} cm^{-3}, and the maximum density can be increased by broadening the frequency response of the interferometer. The apparatus is described and typical results are presented. (ATD)

12780 SPACE–TIME RESOLVED MACH–ZEHNDER INTERFEROMETER MEASUREMENTS OF CROSS-SECTIONAL ELECTRON DISTRIBUTION IN THETA-PINCH PLASMA. Roberts, Howard Nixon. Austin, Tex., Univ. of Texas, 1968. 139p. Thesis.

In theta-pinch deuterium plasmas end losses, instabilities, axial density minima, neutron production, and plasma luminosity are investigated and correlated for 0.005 to 0.10 torr, +4.0 to −4.0-kG bias B field, and 17- to 55-kG peak B field. For 0.04 to 0.10 torr a Mach–Zehnder interferometer illuminated by a 175-MW (6943 Å) giant pulse ruby laser and axially coupled to the plasma yields space–time resolved cross-sectional electron distributions. The cold gas in the 20.63-cm-long one-turn coil region inside the 5.08-cm-ID quartz vacuum chamber is ~99% preionized and preheated to ~2 eV, subjected to an axial-bias B field, and compressed by strong axial B fields which reach their peak values in 3.4 μsec (at $t = 3.4$ μsec). A digital computer technique employs information extracted from the interference fringe patterns to determine the total number of electrons N_e present. The time evolution of N_e yields time constants (τ's) for plasma loss out the ends of 3 to >100 μsec prior to peak B and 0.5 to 4 μsec afterwards. A plasma end-loss model assuming free flow near ion thermal velocities through apertures at the ends incorporates these τ's to predict aperture radii—1 to 5 mm prior to peak-B and 5 to 10 mm afterwards. Ion Larmor radii are 3 to 5 mm. The radii of density minimum regions observed are 3 to 8 mm. Nonrotating flute and flute-like instabilities form near 1 μsec in all reverse biased plasmas. Mode numbers and evolution characteristics are highly dependent on reverse bias strength. Kink instabilities rotating near 1 rev/μsec always develop after 3 μsec for −2.7 to −4.0 kG and in certain cases for −1.3 kG bias. A density minimum region is observed near the plasma axis to at least 1.1 μsec and for certain conditions persists later than 3 μsec. The density minima are attributed to trapped reverse bias fields. For neutron producing conditions, detectable neutron outputs always commence within 0.2 μsec after the minimum region fills in, implying transferral of reverse-trapped-field energy to the ions. Neutrons result only from the more stable plasma conditions for −2.7 to −4.0 kG bias, implying that they are of thermonuclear origin. Plasma luminosity viewing axially through a Kerr cell shutter is deduced to be highly representative of electron distributions. "High-β" plasmas are inferred by the diffraction patterns observed on shadowgraphs at plasma boundaries and by a refraction deflection model which predicts maximum deflections observed. Kerr cell photography in the "low-pressure" regime reveals the presence of luminous radial striations prior to 0.5 μsec. The number of striations increases from 8 to 32 for pressures from 0.005 to 0.02 torr. A standing ion wave structure is inferred from the striation regularity. He–Ne laser coupled resonator data agree to within ±30% to the interferometer data. Numerical predictions of a modified Hain–Roberts digital computer code agree with the experimentally deduced trends. (Diss. Abstr.)

12781 MEASUREMENT OF ELECTRON ENERGY AND DENSITY IN AN H. F. ELECTRODELESS RING DISCHARGE. Chandraker, K. (Univ. of Salford, Eng.). Z. Phys., 219: 348-53(1969).

The electron temperature T_e and the electron density were measured as functions of the radial distance in a 10-Mc electrodeless ring discharge in hydrogen in the pressure range 0.1 to 0.3 torr. It was found that T_e remains nearly constant along the radius of the cylindrical vessel. The measured values of T_e have been compared with those observed by other workers and an estimate of the effective electric field in the discharge has been made. From this estimate it has been inferred that even after the first stage of the ring discharge is well established the longitudinal component of the electric field remains of considerable importance. The radial density distribution of the electrons was found to be different from those in a uniform electric field. This deviation in the radial density distribution has been attributed to the influence of the azimuthal electric field. (auth)

12782 FOCUSED FABRY–PEROT RESONATOR FOR DYNAMIC MEASUREMENTS OF PLASMA DENSITY. Ullschmied, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 1211-21(1968).

A description is presented of an open microwave resonator of the Fabry–Perot type for the 8-mm band, designed for dynamic measurements of plasma density. The results of measurements of the characteristic value of the resonator, i.e., the spectra, loaded and unloaded Q, beam widths and field distributions are reviewed and compared with the theoretical values. The problem of coupling is analyzed and a formula for the loaded Q is derived. Expressions for calculating the parameters of the measured dielectric (plasma) are given and some results of measurements are presented. (auth)

12783 SCATTERING OF CHARGED PARTICLES BY PLASMA FLUCTUATIONS. Roque, Celso Reyes. Iowa City, Iowa, Univ. of Iowa, 1968. 147p.
Thesis.

The possibilities of the scattering of charged particles for use as a plasma probe are investigated. Formal expressions for the mean-square deflection of a beam of test particles from a spatially uniform plasma are derived. Whereas incoherent scattering of electromagnetic waves is governed by the charge density autocorrelation function, particle scattering is governed by the electric field autocorrelation function. The distribution of the scattered particles, in the case of scattering from either thermal fluctuations or any randomly varying fluctuations of the electric field, is shown to be a Gaussian in the deflection angle. The enhanced fluctuations of a current-carrying plasma near the stability boundary do not lead to a drastic increase in the scattering angle. Nonetheless, the effects of the enhanced fluctuations seem to be measurable. The case of scattering from a weakly unstable plasma is also examined. The instability is assumed to have been driven by a tenuous beam of energetic electrons and the electric field energy density is estimated by the quasilinear theory. It is shown that the mean-square scattering angle can be increased by more than an order of magnitude by a suitable beam density or drift velocity. This enhances the potential usefulness of charged-particle scattering as a diagnostic tool for turbulent laboratory plasmas. (Diss. Abstr.)

12784 THE INTERMEDIATE AND HIGH-FREQUENCY NOISE OF PROBES IMMERSED IN GAS DISCHARGES. Hanson, D. G.; van der Ziel, A. (Univ. of Minnesota, Minneapolis). Physica, 33: 429-34(1967).

It is shown that the noise current flowing to probes immersed in gas discharges can at intermediate frequencies be explained in terms of the noise of the space-charge sheath surrounding the probe and of the noise of the bulk plasma. At larger probe currents the latter noise source predominates. It is suggested that the same process is responsible for the high-frequency noise observed by Galbraith and van der Ziel. (auth)

12785 INFLUENCE OF ELECTRON EMISSION ON PROBE CHARACTERISTICS. Wiesemann, K. (Univ., Marburg, Ger.). Z. Phys., 219: 462-6(1969).

The influence of an electron emission of a spherical probe on its characteristic is calculated in a simplified model for the case of low plasma densities. Comparison of the calculations with measurements taken in helium and xenon show qualitative agreement. (auth)

12786 DERIVATION OF A NEW EXPRESSION RELATING THE ION DENSITY TO THE ION CURRENT FROM A LANGMUIR PROBE. Van Eck, J.; Kinderdijk, H. M. J. (Rijksuniversiteit, Utrecht). Physica, 33: 679-88(1967).

For a plasma consisting of electrons and singly ionized ions, an expression is derived relating the ion current, at a given probe voltage, to the ion density. The derivation is valid in the limiting case of low ion temperature ($T_i \ll T_e$), a high value of the negative probe-potential ($|qV_p| \gg kT_e$) and a long mean free path. The validity of the formula is discussed. The results are compared with computer calculations of different authors and the difference is within 10% in the considered range. The ion densities, calculated with the formula, agree very well with electron densities, calculated from the same probe characteristics (standard deviation 10%), taking into account the secondary emission of the ions. The measurements are performed in the positive column of a helium discharge. (auth)

12787 MEASUREMENTS OF ELECTRON TEMPERATURE AND DENSITY OF SLOW THETA-PINCH PLASMA BY LASER SCATTERING. Hayase, Kiyoshi; Okuda, Takayoshi (Nagoya Univ., Japan). Kakuyugo-Kenkyu, 22: 132-42(Feb. 1969). (In Japanese).

Laser scattering is a very powerful diagnostic technique for the measurement of high-temperature and high-density plasmas. This method has been used in many experiments with successful results. Here 90° scattering is observed to determine the electron temperature and density of the slow theta-pinch plasma of relatively large device, which had been used as a plasma source of BSG devices. The temperature and density are in the order of $\sim 10^{16}$ cm^{-3} and $\lesssim 10$ eV, respectively, so that the plasma is isothermal ($\tau_{ie} < 10^{-6}_{\text{sec}}$), and then ion temperature, which is more important for the experiment, can be estimated as well as electron temperature and density. The characteristics of theta pinch are: L = 60 cm, d = 10 cm, V = 40 kV and E = 11 kJ. The results of scattering theory are simply described for the understanding of experimental results. Observed scattered spectra were ranged from $\alpha = 0.3$ to 1.3 and electron temperature, from about 8 to 4 eV, according to experimental conditions. The time dependence of electron temperature and density was obtained in case of initial gas pressure of 35 mtorr. (NSA of Japan)

12788 EXPERIMENTAL STUDIES OF MAGNETIC FIELD INFLUENCE ON HEAT EXCHANGE OF ARGON PLASMA FLOW WITH CHANNEL WALLS. Rozhdestvenskii, V. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 57-61(Sept.-Oct. 1968). (In Russian).

Experimental studies were made of the influence of a transverse magnetic field on the heat exchange in the initial section of the channel during changes in the mean velocity of flow, the temperature of the channel walls, and the orientation of transverse cross section of the rectangular channel in relation to the magnetic field direction. The influence of the slightly ionized additive to the flow on the heat exchange during superposition of the magnetic field was also analyzed. The results show that the heat exchange was reduced slightly during magnetic field superposition, but not significantly in the range of parameters investigated. (R.V.J.)

Kinetics (General)

12789 RADIATIVE BEHAVIOUR OF A SHOCK-HEATED ARGON PLASMA FLOW. Horn, K. P.; Wong, H.; Bershader, D. (Stanford Univ., Calif.). J. Plasma Phys., 1: 157-70(May 1967).

Experimental and theoretical studies were made of the decrease in the degree of ionization of shock-heated argon resulting from radiative emission. The studies were based on measurements of the time history of the electron density by means of optical interferometry used in conjunction with a rotating mirror camera. These measurements apply to the quasi-equilibrium region which follows the short electronic relaxation zone behind strong shocks. Loss of energy by radiation led to cooling of the gas as evidenced by the decreasing electron density. The analytical studies were based on the assumption that the dense plasma radiated through both continuum emission and emission from spectral lines. Comparison was made with experimental results, and theory and experiment were in good agreement, for a realistic choice of the parameters contained in the continuum theory. The analysis indicated that line radiation losses could not be disregarded. Sizeable loss resulted from lower level bound-bound transitions even though these lines experienced absorption. (auth)

12790 ELECTRIC-FIELD PENETRATION INTO A PLASMA WITH A FRACTIONALLY ACCOMMODATING BOUNDARY. Mason, Rodney J. (Massachusetts Inst. of Tech., Cambridge). J. Math. Phys. (N.Y.), 9: 868-74(June 1968).

Landau's field penetration study is extended to a plasma with a boundary that reflects a fraction σ of the incident electrons specular and diffuse reflection, and series solutions for fractional accommodation are obtained. At great depths in the plasma the field is found to exhibit negligible σ dependence for ω and ω_p and weak dependence through a factor $(1 + \sigma)$ at other frequencies. (auth)

12791 FAST RANDOMIZATION OF AN ELECTRON GAS BY TRAPPED ELECTRO-ACOUSTIC WAVES. Ali Kettani, M.; Hoyaux, M. F. (Carnegie Inst. of Tech., Pittsburgh). Appl. Sci. Res. (The Hague), 19: 370-88(Oct. 1968).

A simplified theoretical model is presented for a phenomenon of fast randomization of an electron gas, investigated experimentally in this laboratory. It is assumed that a certain region in constricted electrical discharges, called "plasma sac" can become the center of trapped electro–acoustic waves generated by a beam–plasma interaction. The interaction between those waves and the electron gas is treated by a pseudo-collisional method, leading to a generalization of Boltzmann's H theorem. The velocity distribution which is essentially Maxwellian with a significant deficiency in the fast electron tail, is deduced. (auth)

12792 INVESTIGATION OF PULSE DISCHARGE IN AXIAL-TURBULENT AIR FLOWS. Kiselevskii, L. I.; Shimanovich, V. D.; Shipai, A. K. (Inst. of Physics, Minsk). Teplofiz. Vys. Temp., 6: 30-4(Jan.-Feb. 1968). (In Russian).

Investigations of the plasma of pulse discharges in axially turbulent air currents are reported. The temperature profiles of the plasma of such discharges were experimentally determined. An evaluation was made of the possible difference of the electron and gas temperatures. (tr-auth)

12793 MICROWAVE STUDY OF THE ELASTIC SCATTERING OF ELECTRONS FROM ARGON ATOMS. Glick, H. S.; Jones, T. G. (Univ. of Colorado, Boulder). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 4-12(Jan. 1969).

A shock tube-microwave reflection method has been used to study the elastic scattering of electrons from argon atoms. In the present experiments, argon was mixed with small concentrations of air and was heated to temperatures ranging from 3500° to 4750°K. At these conditions, the air ionized rapidly and produced essentially all the electrons that interacted with the microwaves. Thus, the argon–air plasmas had well-defined geometrical, chemical, and thermodynamic properties. The power reflection coefficients produced by such plasmas were measured. The present measurements have been compared with the monoenergetic data of Frost and Phelps, Golden, and Normand, as well as with the dc conductivity data of Lin, Resler, and Kantrowitz and the microwave measurements of Kelly and of Daiber and Waldron. (auth)

12794 AN EXPERIMENTAL STUDY OF THE MOTION OF A HYDROGEN PLASMA STREAM IN A LINEAR QUADRUPOLE MAGNETIC FIELD. Barney, Gerald Orville. Madison, Wis., Univ. of Wisconsin, 1967. 153p.

Thesis.

The general problem of injection into a transverse magnetic field is discussed. The importance of the electron and ion gyroradii is noted. It is shown that the ion gyroradius is smaller than average displacement required for polarization and $\vec{E} \times \vec{B}$ drift through the plasma whenever $B^2 \geq m_p n/\epsilon_0$. The effect of a velocity spectrum on transverse injection phenomena is considered. It is shown that the streaming velocity is given by $\bar{v}(m_p n/\epsilon B)$, where $\bar{v}$ is the average ion speed. The velocity spectrum is also shown to depress the magnetic field by an amount $\mu_0 nk(M_p\overline{V_p^2} M_e\overline{V_e^2})/2B$, where $\overline{V_p^2}$ and $\overline{V_e^2}$ are the mean square velocity of the protons and electrons as measured in a reference frame moving with the plasma. The development of a highly reproducible coaxial plasma gun is described. The dependence of the exhaust velocity on electrode length, gas load, and pressure distribution and operating voltage is investigated. The energy spectrum of the gun exhaust is discussed for the standard operating mode in which the exhaust density is about 10^{19} m^{-3} and the average directed ion velocity is about 1.4×10^5 m/sec. The motion of the gun exhaust plasma along the axis of a linear quadrupole magnetic field is studied with the high-impedance probes. Potential contours show the development of a double vortex flow structure in qualitative agreement with J. W. Poukey's self-consistent solutions of plasma flow across a magnetic field. When the plasma stream is injected normally to the axis of the linear quadrupole magnetic field, the time development of equipotentials shows that the plasma splits into two streams moving parallel and anti-parallel to the quadrupole rod currents. The quadrupole field axis and field lines quickly become equipotentials and prevent the plasma from recrossing the lines of force opposite the injection port. The potentials and electric fields in the stream moving antiparallel to the rod currents are much larger than those in the oppositely directed stream. This asymmetry is discussed in terms of the injection process. The motion of the plasma stream through regions of shorted field lines is investigated in detail. Although the inductance of the shorting current path can limit the rate of increase of the shorting current, an ion sheath is found to be the principal factor limiting the depolarization current in long, low-inductance shorting plates placed in the injection aperture. Ion saturation current limits on the discharge of a polarized plasma in the Model C stellarator are also noted. The distance over which a plasma can be stopped by a depolarizing or shorting plate is derived in terms of the degree of collimation and the gyroradius. (Disser. Abstr.)

12795 ON THE PROBLEM OF CONTINUOUS NITROGEN PLASMA EMISSION. Asinovskii, E. I.; Kirillin, A. V.; Kobzev, G. A. (Inst. of High-Temperatures, Moscow). Teplofiz. Vys. Temp., 6: 746-9(July-Aug. 1968). (In Russian).

Nitrogen spectra (λ = 2500 to 20,000 Å) at 1-atm pressure and temperature of 10,000 to 16,000°K were studied in order to determine the negative nitrogen ion photodetachment cross section. A stabilized electric arc was used as a source of nitrogen plasma. Experimental curves obtained for the intensity of nitrogen plasma emission and molecular and electron–ion continuum contributions were analyzed. The N^- photodetachment cross section obtained was in agreement with published data on measurements for the wave length from 4300 to 6300 Å at temperatures from 1,050 to 13,000°K. (R.V.J.)

12796 LANDAU DAMPING OF ION–ACOUSTIC WAVES IN A CESIUM PLASMA WITH VARIABLE ELECTRON-ION TEMPERATURE RATIO. Rajangam, Karthik Balasubramaniam. Los Angeles, Univ. of California, 1967. 101p.

Thesis.

A plasma device is described in which a uniform thermally generated low-temperature cesium plasma is produced inside a hot cylindrical cavity (4.78 cm in diameter and 20-cm long) by adding together ions and electrons from different sources. The walls of the cavity (which can be heated by radiation from external filaments through the range from 1200 to 1800°K) provide most of the ions by contact ionization, while internal tungsten filaments (whose temperature can be varied from 2300 to 3000°K) supply most of the neutralizing electrons. The synthesized plasma obtained in this way has an electron–ion temperature ratio which can be changed by varying the temperature of the walls and the internal filaments. A detailed study of the properties of the synthesized plasma is presented. A Langmuir probe with a coaxial guard cylinder is used to determine the electron temperature, plasma potential, and plasma density (which ranges up to 2.5 × 10^{11} ions/cc). The positive plasma potential varies between 0.5 and 1.4 volts depending on the temperatures of the wall and the neutralizing filaments. The electron temperature (determined from the slope of a Langmuir plot) varies over a corresponding range of 0.12 to 0.44 eV giving an electron–ion temperature ratio that varies between 1 and 2.4. (TSS) (Disser. Abstr.)

12797 PENETRATION OF ELECTROMAGNETIC FIELD INTO MAGNETIZED PLASMA. Bogomolov, Yu. V. (Radiotechnical Inst., Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 11: 618-20(1968). (In Russian).

Penetration of electromagnetic fields into magnetic plasma was resolved, assuming that the plasma occupied a semispace and normal incidence of a plane electromagnetic wave. The constant magnetic field is parallel to the plasma boundary, and the ion motion is not taken into account. Equations obtained previously (integral equation for the Fourier electric field component) were identical for the ordinary and nonordinary waves (d_E ord $\neq$ d_E unusual). Calculations made of d_E for both types of waves without considering the longitudinal field showed good agreement. (R.V.J.)

12798 NONLINEAR THEORY OF ELECTROMAGNETIC WAVE ATTENUATION IN PLASMA. Erokhin, N. S.; Mazitov, R. K. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 11-17(Sept.-Oct. 1968). (In Russian).

Absorption of circularly polarized electromagnetic waves propagating in plasma along a magnetic field was investigated. Precision equations for particle motion in resonance regions were resolved by elliptic functions. Nonlinear attenuation decrement was found to be of oscillatory type, and at $t \to 0$, it coincided with the decrement obtained by linear theory, and at $t \to \infty$ in the absence of collisions it converged to zero. The influence of collisions on the wave absorption was estimated. All plasma particles were separated into groups, resonance and nonresonance. The nonresonance particle velocity distribution function was considered as in the case of a nonattenuated wave. The resonance particle distribution function in the initial moment was considered to be Maxwellian. Nonlinear equations for resonance particle motion were integrated with precision. The analysis covers the thermal motion for resonance particles only, while nonresonance particles were considered to be cold. (tr-auth)

12799 THEORY OF EQUILIBRIUM AND STABILITY OF HIGH-CURRENT DISCHARGE IN DENSE OPTICALLY TRANSPARENT PLASMA. Rozanov, V. B.; Rukhadze, A. A.; Triger, S. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 18-25(Sept.-Oct. 1968). (In Russian).

Studies of equilibrium and stability of high-current discharge in a dense optically transparent plasma showed that, in contrast to the nontransparent plasma, the temperature of transparent discharge varies in the same manner as other hydromagnetic magnitudes. An analysis of small oscillation spectra revealed that, within the limits of geometric optics, the discharge was unstable. The discharge stability was investigated under conditions of bremsstrahlung and other types of radiation; general cause of discharge instability under the conditions studied, was overheating caused by weak thermal flow that was incapable of compensating for the rising temperature fluctuations induced by Joule heating. A theory of stability was developed for the case of optically transparent plasma in which the main part of radiation is transported by quanta with mean free path exceeding the characteristic dimensions of the systems. (R.V.J.)

12800 ION-ACOUSTIC WAVES IN A COLLISION-DOMINATED MERCURY-VAPOR PLASMA. Aksornkitti, Suthi. Iowa City, Iowa, Univ. of Iowa, 1968. 90p.
Thesis.

The experiments are an extension of the work of I. Alexeff and W. D. Jones to a collision-dominated plasma. Theoretically, a fluid model analysis for such a plasma is carried out. In particular the following were observed and identified: (1) an anisotropic nature of wave propagation in a spherical discharge tube which can be related to ambipolar diffusion; (2) a dispersive region of the ion waves beneath the ion–neutral collision frequency; (3) a reflection of ion waves in a "perturbed" plasma; (4) pseudo-ion waves which behave like bursts of accelerated ion from a grid exciter; (5) stationary striations in a cylindrical discharge tube. It is also suggested that the ion–acoustic waves can be useful for basic gas-discharge diagnostics. Numbers are obtained for the ion–neutral collision frequency and the ambipolar diffusion coefficient which are checked by independent methods and agree with those found in the literature. (Diss. Abstr.)

12801 ANTENNA IMPEDANCES IN A COLD PLASMA WITH A PERPENDICULAR STATIC MAGNETIC FIELD. Galejs, Janis (Sylvania Electric Products, Inc., Waltham, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 728-36(Nov. 1968).

A flat strip antenna is embedded in a magnetoionic medium with its longitudinal axis perpendicular to the static magnetic field. The antenna characteristics differ for antennas oriented with their surfaces parallel and perpendicular to the static magnetic field. In the former case, there are no resistance peaks for frequencies near the plasma frequency and the reactance of a short antenna is capacitive for low frequencies. For frequencies near the gyrofrequency, the antennas are electrically longer for the parallel orientation of their surfaces. The accuracy of the solutions is illustrated by computing the tangential electric surface fields that are excited by the approximate current distributions used in the impedance computations. (auth)

Kinetics (Experimental)

Refer also to abstracts 12617 and 12911.

12802 FUNDAMENTAL APPROACH TO HIGH-FREQUENCY BREAKDOWN OF GASES. Epstein, Melvin; Lenander, Carl J. (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 11: 2753-8(Dec. 1968).

An evaluation has been made of the net ionization frequencies of air inferred from breakdown measurements. This has been accomplished by comparison of such data with the corresponding values obtained from numerical solutions of the Boltzmann equation. Good agreement is found at high pressures, but the comparison deteriorates with decreasing pressure. This trend is attributed to the use of the effective field concept and the absence of nonuniform field corrections in the processing of the experimental data. Calculations are presented that show that breakdown fields calculated with data obtained from solutions of the Boltzmann equation and combined with an appropriate nonuniform field analysis are in good agreement with experimentally measured breakdown fields. It is concluded that the latter approach provides a more rational and accurate method for predicting high-frequency breakdown than previously available methods. (auth)

12803 FLOW IN A MAGNETIC SHOCK TUBE WITH UNSTEADY MAGNETIC FIELD. Yasuhara, Michiru (Nagoya Univ., Japan). Phys. Fluids, 11: 2567-76(Dec. 1968).

Flow in a magnetic annular shock tube is analyzed, in which both the driving and applied magnetic fields vary with time. First, one-dimensional flow is solved by the hypersonic similarity method for the case in which both fields are proportional to a power of time. Second, the local similarity approximation is described to treat more general case in which the fields are smooth functions of time. Third, a purely numerical integration using Lax's finite difference method is carried out for a flow with a sinusoidal driving magnetic field, in which a typical nonsimilar nature of the solution appears in some parts as well as locally similar ones in other parts of the flow. Next, some experiments on a magnetic annular shock tube using air as the working gas, are described with special interest paid to the effect of unsteady azimuthal magnetic field on the flow, and comparisons with theoretical predictions are reported. (auth)

12804 THE INTER-ELEMENT EFFECT CAUSED BY READILY IONIZABLE ELEMENTS PRODUCED IN ATOMIC SPECTROSCOPY LIGHT SOURCES. II. THE CONTRIBUTION OF THE INTERNAL ELECTRICAL FIELD ARISING FROM AMBIPOLAR CHARGE CARRIER DIFFUSION TO THE INTER-ELEMENT EFFECT. Schirrmeister, H. (Institut fuer Spektrochemie und Angewandte Spektroskopie, Dortmund, Ger.). Spectrochim. Acta, Part B, 24: 1-12(Jan. 1969). (In German).

The results of an experimental investigation of the inter-element effect in a plasma jet, described in part I of this paper, are interpreted. The electric field inside the plasma jet, caused by ambipolar diffusion, is calculated. It is shown in which way the electric field determines the distribution of easily ionizable elements in the plasma and how, on the other hand, such elements change the electric field and consequently influence one another. The theoretical results, concerning changes of the electric field by adding potassium to the plasma, were tested by probe measurements. (auth) (UK)

12805 SKIN-DEPTH EFFECT OF A CYLINDRICAL SHOCK-PRODUCED PLASMA. Aro, T. O.; Walsh, D. (Oxford Univ., Eng.). J. Plasma Phys., 2: 65-72(Feb. 1968).

The microwave reflection from and transmission around the shock-produced argon plasma whose electron density is greater than 10^2 times the critical electron density for the 9-Gc wave have been found to be similar to those of a metal rod. But the skin depth of the wave in the plasma plus the thickness of the shock boundary layer is found to affect significantly the amount of microwave power transmitted round the cylindrical surface of the plasma. (auth)

12806 ON THE AC ELECTRICAL CONDUCTIVITY OF A LORENTZ GAS. Fu, J. H. M.; Ong, R. S. B. (Univ. of Michigan, Ann Arbor). J. Plasma Phys., 2: 1-8(Feb. 1968).

Often one is interested in the electrical conductivity of a plasma for frequencies of the applied electric field comparable to or greater than the effective collision frequency. For the purpose of obtaining an order of magnitude estimate of the conductivity a Lorentz gas model with a Fokker–Planck collision term is used. For this simple model a formula for the ac electrical conductivity for two limiting cases is derived in closed form. The first term of the expression for the conductivity in the case where ω/k is very large agrees with that obtained by Bernstein & Trehan (1960) for the spatially homogeneous case, while the effect of the spatial gradients is indicated in the higher-order terms. In the case where ω and k are both equal to zero the expression for the dc electrical conductivity of Spitzer (1962) is recovered. (auth)

12807 EXPERIMENTAL CHECK OF THE EQUIVALENT PRESSURE CONCEPT OF THE ARC DISCHARGE WITH THE HOT CATHODE IN MERCURY VAPOR. Kostin, V. N.; Sorokina, V. M.; Tomov, I. K. (Kharkov State Univ.). Zh. Tekh. Fiz., 38: 1005-9(June 1968). (In Russian).

An experimental test was carried out for two theoretical expressions defining the so-called equivalent pressure which measures the apparent increase in the pressure of a gaseous discharge due to the action of a transverse magnetic field. The experiments were carried out on mercury vapor rectifiers GRI-0.25/1.5 and on mercury thyratrons of type Tr-212 (modified thyratron TG-212). The dependence of the firing voltage on the mercury vapor pressure, the volt–ampere characteristics, and general starting conditions of the thyratrons was determined, and the results were compared with those predicted by the above theoretical equations. The experimental results were in good agreement with those from theoretical expressions, so that the theoretical expression may be used for the design and control of mercury vapor rectifiers and thyratrons, subjected to applied transverse magnetic fields. (ATD)

12808 VACUUM ULTRAVIOLET RADIATION STUDIES FOR PHOTOABSORPTION BY MODERATE-TEMPERATURE PLASMAS. Blackwell, Harvel Eugene. Los Angeles, Univ. of Southern California, 1968. 71p.

Thesis.

Techniques for the study of photoabsorption by moderate-temperature plasmas (T ~ 1 eV) have been investigated with particular reference to the high-current, wall-stabilized, cascade arc. Such an arc has been constructed and made to operate in conjunction with a vacuum-ultraviolet spectrograph and a low-pressure spark light source. Observations of plasma emission and absorption were made in the wavelength region below 1000 Å where the wavelengths corresponding to the ionization threshold energies of most atoms and molecules occur. Studies have been made with argon, neon, hydrogen, and oxygen. Argon and hydrogen, in particular, exhibit strong Stark-broadened line emission, and the recombination of the singly ionized atoms and electrons yields a strong emission continuum. The transmission observed here of vacuum ultraviolet spark source radiation through the plasma of the arc, as through the shock tube plasma, will make possible accurate photoionization cross-section measurements of ionized plasma constituents and of atomic constituents chemically unstable under normal conditions. (Diss. Abstr.)

12809 STRIATION OF THE PLASMA OF A SINGLE-POLE HIGH-FREQUENCY HIGH-PRESSURE DISCHARGE. Janca, J.; Talsky, A. (Purkyne Univ., Brno). Czech. J. Phys., 18: 1227 (1968).

A single-pole hf discharge was excited in air, N_2, and Ar, at a pressure from 10 to 760 torr. The output of the hf generator amounted to 100 to 250 W, the exciting frequency 7.27 and 45 Mc. The light radiation of the discharge was picked up by means of photomultipliers. A diagram of the layers is given. (M.O.W.)

12810 INTERACTION OF PLASMOIDS WITH MAGNETIC FIELDS. Zorskie, Joseph William. Hoboken, N. J., Stevens Inst. of Tech., 1968. 123p.

Thesis.

Plasmas from small button-type sources are investigated. The temperature, velocity peak density, and total mass are determined. The mechanisms of production of this plasma are discussed. The plasma is directed transversely across homogeneous magnetic fields and the subsequent interaction is studied. The movement and configuration of the plasma, both across and along the field lines, and the dependence on plasma ion mass and magnetic field strength are determined. Internal plasma structure is probed and internal plasma motion (rigid rotation) is confirmed. Theoretical work on plasma vortices is reviewed and compared to the experiment. Evidence from a Plasma Çamera is presented which indicates a preferred direction ($-\vec{v}X\vec{B}$) for the growth of plasma protuberances. (Diss. Abstr.)

12811 THE APPROACH TO QUASI-EQUILIBRIUM OF A HIGH-CURRENT-DENSITY, PULSED GLOW DISCHARGE IN HELIUM AND HELIUM–HYDROGEN MIXTURES. Allario, Frank. Brooklyn, Polytechnic Inst. of Brooklyn, 1968. 140p.

Thesis.

Results of a study on high-current-density, pulsed glow discharges in helium and helium–hydrogen mixtures are presented. This study traces the temporal development of several parameters of the pulsed discharges in the interval of time between the application of the voltage pulse until a condition of quasi equilibrium is attained late in the discharge pulse. These discharges, of 1.3-μsec duration, are sustained in 2.5-cm-diameter Pyrex tubes with interelectrode gaps variable between 10 and 40 cm. The pressure range runs from 0.50 to 5.0 torr. As the discharges approach the condition of quasi equilibrium, current densities of the order of 15 A/cm^2 are maintained, without any emission lines of the electrode material appearing in the spectrum of the discharge. Four parameters of the discharge are obtained as a function of time: the spatial distribution of the light intensity emitted by the discharge, the electron temperature distribution, the distribution of axial electric field across the discharge and the wall potential distribution. As the luminosity emitted by the pulsed discharge evolves in time, the electron temperature distribution in the luminous regions are obtained using the singlet-to-triplet line intensity ratio technique. Electron temperatures of the order of 18 electron volts were detected in the negative glow when quasi-equilibrium was reached. Electron temperatures of the order of 10 eV were detected in the positive column. The buildup of electric field in the vicinity of the cathode is determined by time-resolved measurements of the Stark splitting of lines in the helium and hydrogen spectrum. The axial component of the electric field and the wall potential distribution in the rest of the discharge are obtained from signals induced on a series of externally placed electrostatic ring probes. Fields as high as 78 kV/cm were detected at the cathode face, while uniform fields of the order of 10 V/cm-torr were found in most of the rest of the discharge. Comments are made on the transition region between the high and low field regions in the discharge. It is suggested that the propagation of the negative glow from anode to cathode can be explained at relatively high pressures by the collapse of the tail of the high electric field at the cathode face. At the lower pressures, the heating of the negative glow plasma by high-energy primary electrons accelerated by the high-cathode fields can account for the observed propagation of the negative glow in time. The results obtained are compared with the properties of abnormal dc glow discharges sustained in the same pressure range. (Diss. Abstr.)

12812 LASER-GENERATED PLASMAS AND THEIR APPLICATION TO HIGH-POWER MICROWAVE SWITCHING. Stevenson, David Michael. Ithaca, N. Y., Cornell Univ., 1968. 208p.

Thesis.

The production and properties of dense, rapidly expanding carbon plasmas, generated in vacuum by irradiating graphite surfaces with the focused beam of a Q-switched ruby laser giving 6 MW of peak power in a 25-ns pulse are presented. The microwave properties of plasmas generated from a target at the center of the broad face of X-band waveguide have been studied to assess the potential of using these plasmas for rapidly switching microwave powers in excess of 10 MW. The ions from the plasmas have been collected on a plate close to the waveguide wall opposite the laser target. Microwave diagnostics with rf powers of less than 0.1 W and plate-current measurements showed that the plasma expands across the guide in about 0.1 μs, and that during this time, rf propagation in the guide can be explained in terms of an expanding metal sphere model for plasmas containing more than 10^{13} ions. The plasma cuts off the waveguide until the electron density falls below about 5×10^{11}/cm^3 due to recombination at the walls and within the volume. During the plasma decay the interference pattern expected from a decaying plasma slab in waveguide is observed. Microwave "switching" experiments using rf powers up to 50 kW showed that due to nonlinear interaction between the plasma and rf strong absorption of the rf power by the plasma can occur and therefore that a practical switching arrangement would require the use of reactive waveguide elements in conjunction with the laser-generated plasma. A gasdynamic model for the plasma expansion is analyzed and shown to agree with the observed experimental results. A preliminary investigation of the possibility of using photoionization of a filler gas to detect and measure the vacuum uv radiation from the laser-generated plasma using microwave techniques has been made. (Diss. Abstr.)

12813 THERMALIZATION OF ELECTRONS IN A PLASMA OF A SHORT ARC IN CESIUM VAPOR. Morgulis, N. D.; Korchevoi, Yu. P.; Dudko, D. Ya. (Kiev State Univ.). Zh. Tekh. Fiz., 38: 1065-74(July 1968). (In Russian).

The thermalization of electrons emitted from a hot cathode and accelerated in the near-cathode potential jump is investigated experimentally. The thermalization takes place in a low-temperature cesium plasma, in a low-voltage arc discharge. The plasma diagnostics were conducted by means of a movable Langmuir probe and a coaxial resonance loop for measuring plasma oscillations. The results of the diagnostics show the existence of plasma oscillations in the frequency range 1700 to 2100 Mhz. These are sharply outlined spectral curves, one near 1700 Mhz and the other near 2100 Mhz. Current–voltage characteristics determined by the Langmuir probe show two distinct curves. The first group of curves corresponds to slow, Maxwellian electrons with T_e ~ 6000°K. The second group represents fast electrons with energies close to the near-cathode potential jump (6 V). A variety of measured data points at various interelectrode pressures and spacing indicates that thermalization of the emitted and accelerated electrons takes place primarily through elastic and inelastic collisions with cesium atoms. (ATD)

12814 FIELD REVERSAL IN AN ELECTRONEGATIVE PLASMA CONTAINING MOVING STRIATIONS. Gray, Eoin W. (Univ. of British Columbia, Vancouver). Z. Phys., 220: 86-7 (1969).

Evidence is presented to show that under some conditions the radial ambipolar field, in a diffuse positive column containing moving striations, reverses near the discharge tube axis. (auth)

12815 INTERACTION BETWEEN PLASMA FLOW AND A MAGNETIC BARRIER: SHOCK FORMATION. Leloup, C.; Taussig, R. T. (Nagoya Univ., Japan). Nucl. Fusion, 8: 362-4(Dec. 1968).

A supersonic plasma flow guided by a magnetic channel up to a magnetic barrier is considered. For analytic simplicity, one assumes infinite conductivity, no plasma flow across the magnetic field and treat a one-dimensional problem for a collision-dominated plasma. (M.O.W.)

Kinetics (Theoretical)

12816 (AD-669354) AN ANALYTICAL STUDY OF A FLUID CYLINDER ARC MODEL BALANCED BY CROSSED MAGNETIC AND FLOW FIELDS. Final Report, November 1, 1966-October 31, 1967. Kihara, D. H.; Han, L. S. (Ohio State Univ., Columbus. Dept. of Mechanical Engineering). Jan. 1968. Contract F33615-67-C-1176. 105p. (ARL-68-19). CFSTI.

A free-burning electric arc subjected to a crossflow and a cross magnetic field is represented by an impermeable fluid cylinder model. This model allows for both momentum and energy exchange processes by viscous forces and conductive heat transfer around the cylindrical surface. Convective effects through the surface are assumed not to occur. The fluid dynamic and heat transfer characteristics within and outside the fluid cylinder model are investigated by proper matching of both flow and temperature fields at the cylinder boundary. The study shows that the arc radius and centerline temperature can be calculated provided the magnitudes of the applied external fields are known. The external fields are the electric field, the magnetic field and the cross flow field. The relationship among these parameters for a nitrogen arc is shown graphically. (auth) (TAB)

12817 (CONF-680832-1) PLASMA HEAT TRANSFER. Eckert, E. R. G. (Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering). [1967]. 11p. American Society of Mechanical Engineers, New York, N. Y. $1.50.

From 10th National Heat Transfer Conference, Philadelphia, Pa.

The various transport processes which contribute to energy fluxes in ionized gases are discussed. The discussion is restricted to a pressure and temperature range for which the gas can be considered as a continuum. (M.O.W.)

12818 (NP-17747) THE INFLUENCE OF ELECTRIC FIELD ON THE MOTION OF PARTICLES IN HELICAL FIELDS. Preprint No. 99. Popryadukhin, A. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 22p. (In Russian). Dep.

The influence of deviation of equipotentials from magnetic surfaces on the motion of various particles was studied. It is shown that, in addition, when particles are re-grouped by velocity space, the electric field of flat $\alpha\tau \ll 1$ harmonics may result in mixing up trajectories exceeding the Larmor radius. Diagrams of magnetic resonance coils, various areas in the velocity space with various particle motions at $\Delta\bar{\chi}_0 < 0$, regions of various types of particle motion at $\Delta\bar{\chi}_0 > 0$, cylindrical and toroidal coordinate systems, and a model of resonance particle diffusion are included. (R.V.J.)

12819 (NP-17757) ELECTRODYNAMIC STUDIES ON WAVES IN A SYSTEM OF TWO ELECTRONIC COUNTERSTREAMS AND A PLASMA. Jarmen, Anders (Uppsala Univ. (Sweden)). 1968. 120p. Dep.

Thesis.

A beam-plasma system was studied and a macroscopic description of electromagnetic phenomena is given. The system studied is a parallel-plate waveguide filled with a symmetrically located slab composed of a plasma and two counterstreaming electron beams in a background of neutralizing ions. The following cases are discussed: The cold and unmagnetized system, unmagnetized system with a hot background plasma, longitudinally magnetized system with a hot background plasma, and nonlinear waves. (Sweden)

12820 (SC-T-69-1001) STUDY OF A DECAYING HELIUM PLASMA HAVING A HIGH NEUTRAL PARTICLE DENSITY. Deloche, Robert. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from report CEA-R-3450. 29p. Dep. CFSTI.

An abstract for the original report appeared earlier in NSA 22: 39057. (M.O.W.)

12821 TIME HARMONIC, SPHERICAL HARMONIC, AND POWER SERIES EXPANSION OF THE BOLTZMANN EQUATION. Morrone, Terry (Adelphi Univ., Garden City, N. Y.). Phys. Fluids, 11: 2617-20(Dec. 1968).

The time dependence of the expansion coefficients of the spherical harmonic expansion of the electron velocity distribution is expanded in a Fourier series. The new coefficients are in turn expanded in a power series in the small parameter δ, the fraction of energy an electron loses per collision. Relationships between the coefficients are derived from the Boltzmann equation. The expansion is applied to calculating harmonic currents in weakly ionized gases in alternating electric and constant magnetic fields. (auth)

12822 KINETIC MODEL FOR THE SHOCK STRUCTURE IN A BINARY GAS MIXTURE. Beylich, Alfred E. (Technische Hochschule, Aachen). Phys. Fluids, 11: 2764-7(Dec. 1968).

An extension of the two-fluid model to the problem of plane stationary shock waves in binary mixtures of monatomic inert gases is made. No overshoot exists in the velocity profiles; however, there is an overshoot in the temperature profile. (auth)

12823 FORM OF INELASTIC TRANSPORT CROSS SECTIONS. Fox, R. L. (Sandia Lab., Albuquerque N. Mex.). Phys. Fluids, 11: 2767-8(Dec. 1968).

The form of the inelastic transport cross sections is developed from the macroscopic transport equations. The diffusion cross sections for the Lyman α transitions in hydrogen are discussed. (auth)

12824 DOUBLE-ADIABATIC, HYDROMAGNETIC EQUATIONS FOR ELECTRONS WITH PRESSURE GRADIENTS. Abraham-Shrauner, Barbara (Washington Univ., St. Louis). Phys. Fluids, 11: 2768-71(Dec. 1968).

Double-adiabatic hydromagnetic fluid equations for electrons and ions are given that reduce to the Chew-Goldberger-Low equations or adiabatic, nonlinear ion-acoustic equations in special cases. (auth)

12825 NEW KINETIC EQUATION FOR PLASMAS. Wigley, T. M. L.; Green, H. S. (Univ. of Adelaide). Phys. Fluids, 11: 2771-3(Dec. 1968).

A new form is derived for the plasma kinetic equation in which an operator replaces the distribution function. Transport coefficients can be obtained by a method similar to that of Chapman and Enskog and, under certain conditions, an exact solution can be found. (auth)

12826 MULTIFLUID THEORY FOR STAGNATION FLOW OF PARTIALLY IONIZED PLASMA. Shelton, G. A. Jr. (Sandia Lab., Albuquerque, N. Mex.); Touryan, K. J.; Johnson, D. H. Phys. Fluids, 11: 2773-5(Dec. 1968).

The profiles for the flow of ionized argon past a blunt body are obtained by employing a series truncation method to reduce the partial differential equations to ordinary differential equations and a band-matrix technique for numerical computations. (auth)

12827 PARAMETRIC STUDY OF SHEATH-BOUNDARY INTERACTIONS. Hassan, H. A.; McDonald, P. W. (North Carolina State Univ., Raleigh). Phys. Fluids, 11: 2775-7(Dec. 1968).

A parametric study of the effects of emission, reflection, and surface ionization on the current densities and heat fluxes to a cathode is presented. The computations were carried out for cesium and argon assuming a tungsten electrode. (auth)

12828 STABILITY OF ELECTROMAGNETIC WAVES PROPAGATING PERPENDICULAR TO THE MAGNETIC FIELD IN A MIRROR CONFIGURATION. Ossakow, Sidney L. (Lockheed Palo Alto Research Lab., Calif.). Phys. Fluids, 11: 2778-9 (Dec. 1968).

In an infinite plasma with an applied unform magnetic field B_0 the loss cones of an anisotropic Maxwellian velocity distribution for electrons has a stabilizing effect on linearly polarized electromagnetic waves propagating perpendicular to B_0. (auth)

12829 VORTICITY GENERATED BEHIND SHOCK WAVES IN CONDUCTING GASES. Ram, Rishi; Upadhyaya, K. S. (Univ. of Allahabad, India). Phys. Fluids, 11: 2586-7(Dec. 1968).

It was shown by Kanwal that the vorticity generated behind shock waves in conducting gases is no longer derivable from purely dynamical relations as in nonconducting gases and the energy equation is essentially needed in the process. A proof, independent of the form of the equation of state and based on the momentum equation alone, is presented for the derivation of vorticity generated behind shock waves in conducting gases under two cases: (i) when the magnetic field is tangential to the shock surface, and (ii) when the magnetic field is normal to it. (auth)

12830 BROWNIAN MOTION OF ELECTRONS. Williamson, J. H. (Univ. of British Columbia, Vancouver). J. Phys., A (London), 1: 629-45(Nov. 1968).

The concepts of Chandrasekhar (1943) are used to derive a new theory which describes the random motion of a particle less massive than the fluid particles. A low-density Lorentz gas with isotropic scattering is used as a model. Probability densities are calculated and the mean square displacement is found to agree with Ornstein's result, $\langle x^2 \rangle = 2D\beta^{-1}(\beta t - 1 + e^{-\beta t})$ only if all particles have the same collision rate. An expression is given for the displacement in a magnetic field, which is valid at all times; in the limit of $t \rightarrow \infty$ the usual diffusion constant is obtained. The theory is applied to the scattering of radiation by electrons in a plasma, and the spectra are found to be narrowed by collisions, although features such as the peaks at the plasma frequency or multiples of the cyclotron frequency are broadened. The collision term used in the linearized Boltzmann equation is more realistic than the widely used BGK term, and the collision rate can vary with speed. (auth)

12831 COLLISION AND IONIZATION EFFECTS IN A PLASMA SHEATH. Hu, Pung Nien; Ziering, Sigi (Space Sciences, Inc., Waltham, Mass.). J. Plasma Phys., 2: 119-34 (June 1968).

The transition domain between collisionless and collision-dominated flows in the environment of a plasma sheath was studied. The onset of collisions also brings into focus the concurrent effects due to ionization, which are retained in the theory. An integral method of iteration is established, and the dominant correction terms due to collision and ionization effects are obtained. Various limiting cases are examined. (auth)

12832 ANOMALOUS HIGH-FREQUENCY CONDUCTIVITY OF A TURBULENT PLASMA. Bertotti, B. (EURATOM–CNEN, Frascati, Italy. Univ., Messina, Italy); De Barbieri, O. J. Plasma Phys., 2: 465-82(Aug. 1968).

The anomalous high-frequency conductivity arising from particle–wave interactions in a multi-species turbulent plasma with no external magnetic field is evaluated. The calculation is made by using the full three-dimensional model of the quasi-linear theory of plasma turbulence for a wide range of frequencies embracing the electron plasma frequency. It is found that the conductivity tensor is anisotropic and slowly time-dependent; this reflects the slow time dependence and the anisotropic character of the distribution functions of the velocities of the particles. It is also found that there is a very narrow range of frequencies (just above the electron plasma frequency) for which the components of the conductivity tensor are negative. The particular case of the two-stream instability is examined in detail. The anisotropic character of the components of the conductivity tensor and their dependence on the frequency of the external field is studied. Finally, some possible means for an experimental check of the calculations are suggested. (auth)

12833 MODEL KINETIC EQUATION FOR AN ELECTRON PLASMA. Baum, Howard R. (Harvard Univ., Cambridge, Mass.). J. Plasma Phys., 2: 485-507(Dec. 1968).

A kinematic model equation for an electron plasma is proposed. The principal new feature of the equation is an attempt to incorporate collision terms which model both short-range two-body scattering and many-body small-angle scattering. The equation is then used to study the time relaxation of a spatially uniform plasma. A simplified form of the model is finally used to analyse sound propagation in the plasma. Dispersion equations are derived and studied in several limiting cases. Landau damping in the small wave-number limit is shown to be less important than collisional damping for most plasmas. (auth)

12834 ELECTRON INTERACTIONS AND QUANTUM PLASMA PHYSICS. Rauscher, Elizabeth A. (Univ. of California, Livermore). J. Plasma Phys., 2: 517-41(Dec. 1968).

The "quantum electrodynamics" of the scattering of radiation from a fully ionized, interacting plasma is considered. The plasma particle interaction must properly be treated quantum mechanically when the electron plasma wave phonon energies are comparable to or greater than the mean random electron energies and/or when the phonon momenta are of the order of magnitude or greater than the average electron momenta in the plasma. In these two circumstances or either one of them, the plasma particle interaction must be treated in a quantum mechanical manner. The "solid-state" plasma recently discussed by D. E. McCumber is an example of a quantum plasma. Whether a classical or a quantum plasma is considered, the collective properties, as well as the single-particle properties, need to be considered. The collective properties of the plasma become important when it interacts with a radiation field in the case where the electron plasma frequency, ω_p, is of the same order of magnitude, or exceeds, the operating radiation frequency ω, i.e., $\omega_p \geq \omega$. A criterion to distinguish the properties of a plasma as to whether it is classical or quantum mechanical in nature can be defined in terms of three fundamental lengths of the electron gas. These definitions hold for a one-component plasma. They are: the classical length βe^2, the Debye screening length $\lambda_D = (4\pi\beta e^2/\rho)^{-1/2}$, and the thermal de Broglie wavelength $\lambda = \hbar(\beta/2m)^{1/2}$ for β defined as $1/kT$. From these three quantities we can define two dimensionless parameters. They are the classical parameter $\Lambda = \beta e^2/\lambda_D$ and the quantum parameter $\delta = ƛ/\lambda_D$ which is a measure of the quantum effects. For a quantum plasma $\delta > 1$ and in the classical limit ($\hbar = 0$), $\delta = 0$, $\Lambda < 1$. When one takes into account the collective behaviour characterized by the plasma oscillations, screening effects are an automatic aspect of the electron plasma gas. As an example of a calculation of plasma properties, a calculation of the generalized dielectric constant for both a low-density plasma in the classical limit and a high-density plasma in the quantum mechanical limit is performed and compared in a suitable manner. (auth)

12835 TRANSPORT COEFFICIENTS OF PARTIALLY IONIZED HYDROGEN. Devoto, R. S. (Stanford Univ., Calif. Institut fuer Plasmaphysik, Munich). J. Plasma Phys., 2: 617-31(Dec. 1968).

Transport coefficients have been computed for partially ionized hydrogen at pressures 0.01, 0.1, 1, and 10 atm and temperatures up to 50,000°K. Theoretical expressions containing accurate collision integrals for charged particles were employed for the calculations. The electrical and thermal conductivities are compared with recent measurements in the wall-stabilized electric arc. Generally satisfactory agreement is noted for the electrical conductivity to 19,000°K, but the computed thermal conductivity is considerably lower than that measured. (auth)

12836 INTERACTION OF A RELATIVISTIC ELECTRON BEAM WITH AN INHOMOGENEOUS PLASMA. Dorman, G. (Polytechnic Inst., Brooklyn). J. Plasma Phys., 2: 557-80 (Dec. 1968).

The investigation of the high-frequency interaction of a relativistic electron beam and a plasma is extended to include arbitrary variation of the plasma density. Analyzing the coupled linearized Vlasov–Maxwell equations by means of a low-temperature expansion of the orbit integrals, a general equation for the electric field accurate to first order in the plasma temperature, beam temperature, and betatron frequency is obtained. This equation is applied to the investigations of transverse and longitudinal modes. A new transverse mode with $|\omega - kV_0| \sim \omega_\beta$ is found to be collisionally unstable. The electrostatic instability is found to be slowed down by both low plasma temperature and low beam temperature, but the betatron oscillations increase the growth rate. A new longitudinal mode with $|\omega - kV_0| \sim \omega_\beta$ is found to be unstable for nonzero beam temperatures. The lowest order correction to the electrostatic growth rate due to a small plasma nonuniformity is obtained. The sign of this correction is found to depend critically on the shape of the inhomogeneity. (auth)

12837 EFFECTS OF INELASTIC COLLISIONS IN LOW-TEMPERATURE, DIFFUSION-DOMINATED DISCHARGES. Airoldi Crescentini, A.; Maroli, C. (CNR, Milan. Univ., Milan). J. Plasma Phys., 2: 581-90(Dec. 1968).

A numerical iteration procedure has been used to obtain the solution of an integro–differential (linear) equation which gives the energy distribution of the electrons of a low-temperature, diffusion-dominated discharge. The equation takes explicitly into account the effects of inelastic electron–neutral collisions. The results presented here have been obtained, as an instance, for helium and neon discharges, in presence of a static and uniform magnetic field. (auth)

12838 OSCILLATING ELECTRIC DIPOLES IMMERSED IN A HOT PLASMA. Watson, S. R. (Univ. of Cambridge, Eng.). J. Plasma Phys., 2: 437-48(Aug. 1968).

The electric fields of an infinitesimal dipole oscillating in a hot plasma are derived in the absence of an external magnetic field; explicit expressions are obtained by making an approximation on the background electron velocity distribution function. These results are applied to investigate the resonance observed at the plasma frequency, and to estimate the radiation resistance of the dipole. (auth)

12839 BOUNDARY-LAYER STRUCTURE IN A SHOCK-GENERATED PLASMA FLOW. PART I. ANALYSIS FOR EQUILIBRIUM IONIZATION. Knoeoes, Stellan (Stanford Univ., Calif.). J. Plasma Phys., 2: 207-42(June 1968).

The structures of some laminar boundary layers in high-density, shock-heated, 1-eV argon plasma flows have been investigated theoretically. The analysis is based upon a three-fluid continuum formulation. Boundary-layer equations have been solved numerically on a digital computer by a finite-difference technique for the case of thermochemical equilibrium and no radiation and applied electromagnetic fields. The induced electric field has been considered and shown to be important. It strongly couples the diffusive motions of the electron and ion fluids, thus forming ambipolar motion except in a sheath region adjacent to the wall. Argon transport properties, calculated from simple kinetic theory, have been used in the analysis. Important parameters, such as the Prandtl number and the density-viscosity product have been found to vary one or two orders of magnitude in the argon plasma boundary layer, a finding in sharp contrast with results for classical, nonionized boundary layers. Solutions have been developed for the simple Rayleigh's boundary layer (forming over an infinite flat plate with an impulsively started motion in its own plane) and for the shock-tube side-wall boundary layer (forming behind a plane, ionizing shock wave moving over an infinite, plane wall). Even in terms of appropriate similarity parameters, solutions (for e.g., velocity and temperature profiles) exhibit strong dependence upon free-stream conditions. Assumptions of chemical and temperature equilibria have been checked from the equilibrium solution. Results indicate equilibrium ionization would not be present in typical argon boundary layers, e.g., at temperatures below 9000°K, at a pressure of 1 atm. Similarly, due to ineffective energy transfer rates between the electron and the heavy-particle fluids and the difference in electron and ion–atom thermal conductivities, the electron temperature would deviate from the heavy-particle temperature in the same temperature region. The electron temperature has been calculated in a linearized model and found to be larger than the ion–atom temperature. (auth)

12840 TIME-DEPENDENT MOTIONS OF THE CAVITY FORMED WHEN A UNIFORM CORPUSCULAR FLUX IS INCIDENT ON THE MAGNETIC FIELD OF n LINE CURRENTS. Burghes, D. N.; Hewson-Browne, R. C. (Univ. of Sheffield, Eng.). J. Plasma Phys., 2: 189-95(June 1968).

Time-dependent motions of the cavity formed when a uniform corpuscular flux is incident on the magnetic field of n line currents are considered. The general problem is formulated and solved in the case of an initially flat-faced cloud of flux approaching and passing the magnetic field of n line currents. The special case of a line dipole is analyzed in some detail. (auth)

12841 TRANSITION FROM AMBIPOLAR TO FREE DIFFUSION IN A DECAYING PLASMA. Maldonado, C. D. (Northrop Corporate Labs., Hawthorne, Calif.). J. Plasma Phys., 2: 167-80(June 1968).

The problem of transition from ambipolar to free diffusion due to charged particle density gradients in a decaying plasma of spherical symmetry is investigated. This investigation is carried out within the framework of the approximate procedure set forth by Allis & Rose (1954). A further simplification is introduced by using only the time-dependent "imperfect" ambipolar diffusion coefficients for the electrons and ions evaluated at the center of the plasma for carrying out calculations. The results for the time dependence of these "imperfect" ambipolar diffusion coefficients and spatial distributions for the charge density, electric field, and potential which are obtained by this procedure are valid for all values of time in the neighborhood of the center of the plasma and for all other positions of space only during the time while the plasma is diffusing in an almost "perfect" ambipolar manner. (auth)

12842 TRANSPORT COEFFICIENTS OF PARTIALLY IONIZED HELIUM. Devoto, R. S.; Li, C. P. (Stanford Univ., Calif.). J. Plasma Phys., 2: 17-32(Feb. 1968).

Transport coefficients are given in tabular form for partially ionized helium in chemical equilibrium at several pressures and for temperatures up to 35,000°K. Simplified theoretical expressions, derived with the Chapman–Enskog–Burnett method, were used for the computations. The convergence of the approximations to the electrical conductivity was also studied. It was found that the first approximation was within 17% of the true value at low ionization in contrast to recent results for argon where it could not be determined if even the fourth approximation had converged to the true value. (auth)

12843 ON THE KINETIC THEORY OF STABLE AND WEAKLY UNSTABLE PLASMA. PART 1. Rogister, A.; Oberman, C. (Princeton Univ., N. J.). Contract AT(30-1)-1238. J. Plasma Phys., 2: 33-49(Feb. 1968). (MATT-583).

A kinetic theory is presented which is valid for both weakly unstable and stable plasma. The theory corrects the conventional Balescu–Guernsey–Lenard description for the weakly stable portions of the fluctuation spectrum. The theory is no longer Markoffian in the distribution function F alone but is in the pair F and I_k, the spectrum of fluctuations. Further the evolution in time from an initially weakly unstable distribution to the stable regime can be described. Even after passage into the stable state the fluctuations can be large and lead to enhanced diffusion across a magnetic field. The coefficient of spatial diffusion is given in this weakly stable (or unstable) state. A strong coupling is found between plasmons and the particles in the distribution with velocities near the phase velocities of the plasmons. There is only weak thermal contact between the plasmons and these particles with the main body of the distribution whenever certain nonlinear processes are of secondary importance. (auth)

12844 ON ION–ELECTRON BEAMS EMITTED BY A PLANE. Winograd, Yeshaiahu Y. (Brown Univ., Providence). J. Plasma Phys., 1: 267-88(Aug. 1967).

The nonlinear one-dimensional steady-state equations which govern the flow of an ion–electron beam emitted from a plane are solved in the phase plane, and it is shown that a perfectly neutralized beam follows for a large range of injection velocities of the electrons. When the velocity of the ions is less than the electron sound speed the transition region for the neutralization has a length of the order of a Debye length $\lambda_D = (kT)^{½} (4\pi Ne^2)^{-½}$, which is a typical plasma sheath. The maximum velocity of injection of the electrons for which neutralization is predicted is, in this case, the sound speed of the electrons. If the electrons are injected with a supersonic speed, they cannot be decelerated continuously to the subsonic speed corresponding to the velocity of the ions. No bound is set on the electron injection velocity from below. When the velocity of the ion beam is greater than the electron sound speed, oscillations with an amplitude which depends on the velocity of injection of the electrons, and a wavelength which depends on the ratio of the ion velocity to the electron speed of sound, are found. In this case the injection speed of the electrons needed to obtain the steady-state oscillatory solution is bounded both from above and from below. Subsonic electrons cannot be accelerated continuously to the supersonic velocity required to match the velocity of the ions, and within the supersonic range there is shown to be a limit (depending on the ratio of the ion velocity to the electron speed of sound, so that faster electrons cannot be decelerated continuously to match the (supersonic) ion velocity. Perturbation analysis for steady-state flows which deviate only slightly from a completely neutralized flow is undertaken, and such steady-state flows are shown to be stable to an infinitesimal disturbance. A step disturbance in the injection velocity of the electrons is shown to propagate relative to the beam with the electron sound speed, and to decay with time, the decay, after a long time, being of the order of $t^{-½}$. (auth)

12845 THE GUIDING CENTRE APPROXIMATION IN LOWEST ORDER. Banos, Alfredo Jr. (Univ. of California, Los Angeles). J. Plasma Phys., 1: 305-16(Aug. 1967).

A simple and direct derivation of the equations governing the motion of a charged particle in space- and time-dependent fields in the guiding center approximation in lowest order is presented. The method of attack is based initially on the expansion scheme of Bogolyubov & Zubarev (1955) combined with Northrop's averaging process over one gyration period. Thus, we first resolve the instantaneous velocity of the particle into three components, $\dot{r} = \hat{e}_1 u + u_E + \hat{\tau} w$, where u is the parallel component, u_E is the familiar E × B drift, and $\hat{\tau} w$ is the instantaneous perpendicular component as measured in a frame moving with the u_E drift. Substituting this expression into the particle's (nonrelativistic) vector equation of motion, resolving it into parallel and perpendicular components, and applying Northrop's averaging process, one obtains the averaged equations of motion, in lowest order, for the components u and w. From the latter equation it is shown that the magnetic moment of the particle is an adiabatic invariant to lowest order. Next, the instantaneous velocity of the guiding center is resolved into two components, $\dot{R} = \dot{r} - \dot{\rho}$, where ρ is a rapidly rotating vector directed from the guiding center to the instantaneous position of the particle. Upon applying Northrop's averaging process one obtains the averaged velocity of the guiding center including the complete set of first-order drifts. From this equation the energy gain equation is reduced to lowest order. It is then shown that the simple averaging prescription applied here is mathematically rigorous and yields correctly all lowest order results in an expansion in reciprocal powers of the cyclotron frequency. (auth)

12846 MODEL FOKKER–PLANCK EQUATIONS. PART II. THE EQUATION FOR A MULTICOMPONENT PLASMA. Dougherty, J. P.; Watson, S. R. (Univ. of Cambridge, Eng.). J. Plasma Phys., 1: 317-26(Aug. 1967).

A model kinetic equation for a plasma containing many species is set up. It is an approximation to the correct kinetic equation but is considerably simpler in form. The collision operator has the property that particles, momentum and energy are conserved, and it gives to good approximation the correct rates of transfer of momentum and energy between all pairs of species. It is also shown that the equation leads to an H-theorem. (auth)

12847 MODEL FOKKER–PLANCK EQUATIONS. PART III. APPLICATION TO TRANSPORT PHENOMENA. Dougherty, J. P.; Watson, S. R.; Hellberg, M. A. (Univ. of Cambridge, Eng.). J. Plasma Phys., 1: 327-39(Aug. 1967).

The Chapman–Enskog expansion is applied to the model Fokker–Planck equation for a plasma. It is shown that the complete set of transport coefficients can be calculated without further approximations. Results are derived first in the absence of any external magnetic field. The transport coefficients are also derived when there is a strong magnetic field, in which case they become anisotropic. (auth)

12848 STATIONARY WAVES AT A PLASMA–MAGNETIC FIELD INTERFACE. Savage, M. D. (Univ. of Leeds, Eng.). J. Plasma Phys., 1: 229-39(May 1967).

The steady two-dimensional "magnetic bottle" in which a moving, compressible, and electrically conducting plasma is confined by a horizontally aligned magnetic field is discussed. It is assumed that dissipation by viscosity and resistivity is negligible and that the plasma–magnetic field interface is free from instabilities of all kinds. The system is now disturbed by introducing magnetic dipoles into the field. A solution for the displacement of the interface is determined using a Fourier transform method, which shows that under suitable conditions stationary waves are generated both upstream and downstream of the dipoles. (auth)

12849 A SINGLE-FLUID MODEL FOR SHOCK FORMATION IN MHD SHOCK TUBES. Hoffman, Alan L. (California Inst. of Tech., Pasadena). J. Plasma Phys., 1: 193-207(May 1967).

A simple single-fluid model is presented which accounts for the behavior of MHD shock-producing devices in which the shock and the driving current sheet are unseparated. By means of both characteristic and similarity solutions, it is shown that unusual plasma behavior is a simple consequence of the fluid equations of motion. The important parameters in determining the performance of MHD shock tubes are the width of the current sheet at breakdown (related to the magnetic Reynolds number) and the current sheet Mach number with respect to the gas at rest. It is shown that, under many conditions, separation is more likely to be achieved with a decrease, rather than an increase, in current sheet speed. Lowering the Mach number is more influential in causing the shock to form at the front of the current sheet raising the magnetic Reynolds number. (auth)

12850 THERMAL CONDUCTANCES IN A COLLISIONLESS GAS BETWEEN COAXIAL CYLINDERS AND CONCENTRIC SPHERES. Wu, Yau (Princeton Univ., N. J.). J. Plasma Phys., 1: 209-17(May 1967).

The thermal conductances in a collisionless gas between coaxial cylinders and concentric spheres have been obtained for arbitrary thermal accommodation coefficients. This exact theory is based on the general theory of thermal conduction of collisionless gas developed recently by Wu, which has been established according to his revised theory of thermal transpiration. The classical theory of thermal conductance between coaxial cylinders by Knudsen and Von Smoluchowski is only accurate to the first power of the temperature difference in which the velocity distribution in the system is assumed to be nearly Maxwellian. However, in the present paper, it is unnecessary to make this usual assumption and the exact theory has been established according to the revised theory of thermal transpiration. (auth)

12851 DIFFUSION OF GASEOUS IONS IN STRONG ELECTRIC FIELDS UNDER THE INFLUENCE OF CHARGE-TRANSFER COLLISIONS. Skullerud, H. R. (Norges Tekniske Hoegskole, Trondheim, Norway). J. Phys., B (London), 2: 86-91(Jan. 1969).

Expressions were obtained for the longitudinal diffusion coefficient, the velocity distribution function and velocity averages $\langle v^n \rangle$, for gaseous ions moving in strong electric fields, taking into account only charge-transfer collisions between the ions and the gas molecules and neglecting thermal energies. No restrictions were imposed on the velocity dependence of the collision cross section $\sigma(v)$. Numerical results are quoted for the case of a collision cross section proportional to the square of the logarithm of the velocity, which is considered the appropriate velocity dependence for resonance charge transfer in monoatomic gases. (auth) (UK)

12852 STABILITY OF A COLD PLASMA TRAVERSED BY TWO ELECTRON BEAMS IN THE PRESENCE OF AN EXTERNAL MAGNETIC FIELD. Isaac, R. J. (Indian Inst. of Science, Bangalore). Can. J. Phys., 47: 249-56(Feb. 1, 1969).

The stability of a cold plasma traversed by two electron beams in the presence of an external magnetic field is investigated. Dispersion relations for both longitudinal and transverse modes have been obtained. These dispersion relations have been discussed with respect to the two limiting cases of long- and short-wavelength disturbances. Apart from this, the dispersion relation for transverse modes has been solved numerically for a number of cases. It is found that the system becomes unstable against long-wavelength disturbances while it is stable against short-wavelength disturbances. In particular, for longitudinal modes, those perturbations whose wavelengths are such that their frequencies are near the corresponding frequencies of either of the two beams are found to be unstable. It is also found, numerically, in the case of transverse modes, that under certain conditions there exists a critical value of the wave number α, say α^*, such that the system is unstable for the perturbations whose wave numbers satisfy the condition $\alpha < \alpha^*$. (auth) (Canada)

12853 THERMODYNAMICS OF UNSTABLE PLASMAS. Fowler, T. K. (John Jay Hopkins Lab. for Pure and Applied Science, San Diego, Calif.). Advan. Plasma Phys., 1: 201-25(1968).

Calculations were made of the energy in electromagnetic and kinetic fluctuations after instability, or turbulence, is fully developed. A thermodynamic theory is then presented. (M.O.W.)

12854 AN EXTENSION TO THE CONVENTIONAL TOROIDAL MODEL OF THE BOSTICK PLASMOID. Butter, D. A. (General Electric Co., Cleveland). Phys. Lett., 28A: 388-9(Dec. 16, 1968).

Time-of-arrival measurements of Bostick plasmoids to an electrostatic probe suggest that the plasmoid motion may be simulated by a uniformly expanding torus with one point fixed at the button source. (auth)

12855 THEORY OF CATHODE POTENTIAL OF GLOW DISCHARGE. Volkov, N. V. (Kuybyshev Construction-Engineering Inst., USSR). Zh. Tekh. Fiz., 38: 1010-15(June 1968). (In Russian).

Processes occurring in the cathode region of a glow discharge are considered, taking into account δ processes. Assuming steady-state conditions, the total discharge current density in the Crooke's dark space is written as the sum of three components $j_0 = j^+_{(x)} + j^+_\delta + j^-_{(x)}$, where $j^+_{(x)}$ is the ion current density, $j^-_{(x)}$ is the density of the electron current formed by α processes only in the Crooke's dark space. The density of the ion current formed by positive ions diffusing from the negative glow is described. Experiments using hydrogen discharge tubes (pressure, 1-mm Hg) with copper, nickel, and aluminum cathodes are described. The results (presented graphically) include the current density distributions for the three current components and for the three cathode materials, and the electric field strength and potential distributions for the three cathode materials. (ATD)

12856 PATH INTEGRAL FOR A CLASS OF NONLINEAR FOKKER–PLANCK PROCESSES. Wiegel, F. W. (Koninklijke/Shell Laboratorium, Amsterdam). Physica, 33: 734-6(1967).

The case is considered where the phenomenological equations governing the irreversible relaxation of the system towards the equilibrium are nonlinear, and where the fluctuations of the macroscopic variables can be described by a Fokker–Planck equation. (M.O.W.)

12857 EXACT GENERALIZED FOKKER–PLANCK EQUATION FOR ARBITRARY DISSIPATIVE AND NONDISSIPATIVE QUANTUM-SYSTEMS. Haken, H. (Univ., Stuttgart). Z. Phys., 219: 411-33(1969).

A density matrix equation in its most general form is discussed. It comprises the action of external fields on the system, internal interactions, as well as the action of dissipative mechanisms (heat baths or reservoirs), which may be Markovian or non-Markovian. A distribution function of a type introduced previously by Haken, Risken, Weidlich is described for atoms. This distribution function, f, which is now formulated quite generally with aid of projection operators, P_{ik}, establishes a connection between the P_{ik}'s and classical variables v_{ik}. By means of f it is possible to exactly calculate all quantum mechanical expectation values by pure c-number procedures. If the basic density matrix equation is Markovian, it is even possible to calculate all time-ordered multitime averages by c-number procedures using f, as had been demonstrated by Haken, Risken and Weidlich. An explicit way an exact c-number partial differential equation for f is derived. It contains derivatives of arbitrarily high order. In important classes of problems, it can be reduced to an ordinary Fokker–Planck equation, however. The new equation has many applications, e.g., in the quantum theory of lasers, nonlinear quantum optics, spin-resonance, and spin-wave theory, as will be demonstrated in forthcoming papers. (auth)

12858 LIGHT SCATTERING FROM MULTICOMPONENT FLUIDS. Blum, L. (Rice Univ., Houston, Tex.). J. Chem. Phys., 50: 17-20(Jan. 1, 1969).

The spectrum of the light scattered by a multicomponent fluid is discussed using the thermodynamic approach originally suggested by Landau and Placzek. The structure of the central Rayleigh line is discussed for two particular cases; the infinitely dilute solution of rigid polymers and a binary mixture. (auth)

12859 TENSOR OF TIME-AVERAGED STRESSES FOR PLASMA WITH AN OSCILLATING FIELD. Klima, R.; Petrzilka, V. A. (Inst. for Plasma Physics, Prague). Czech. J. Phys., 18: 1292-8(1968).

The tensor of time-averaged stresses arising in a plasma under the effect of a magnetostatic and an oscillating field is derived. The plasma is assumed to be collisionless, quasi-neutral, the particle velocities being far smaller than the wave phase velocities. The case of cyclotron resonance is excluded. The resultant tensor is proved to be symmetric. (auth)

12860 CALCULATION OF THE BREMSSTRAHLUNG IN THE REGION OF THE PLASMA FREQUENCY. Slechta, J. (Inst. of Thermomechanics, Prague). Czech. J. Phys., 18: 1299-1308 (1968).

On the basis of the classical theory of radiation produced in incomplete Coulomb interaction, a formula is derived for the coefficient of the bremsstrahlung of fully ionized plasma. In the region of rectilinear approximation a comparison is made with the results of the quantum formula derived from the Born approximation. Furthermore, the influence of dispersion upon the emission coefficient is taken into account; some relations for the region of dispersion are given. (auth)

12861 RESPONSE OF A ONE-DIMENSIONAL VLASOV PLASMA TO EXTERNAL ELECTRIC FIELDS. Harding, Rollin Charles. Iowa City, Iowa, Univ. of Iowa, 1968. 189p.

Thesis.

The response of a one-dimensional electron plasma confined by perfectly reflecting boundaries has been calculated numerically for several externally maintained electric field configurations representing different physical situations. The electron distribution function is expanded in a Fourier–Hermite series. The external fields (of various wave numbers and frequencies) are represented by equivalent charge-density terms in Poisson's equation. In the first situation, the external field is a standing wave oscillating at approximately the resonant frequency for the given wavenumber k_0. The energy of the particle distribution and the envelope of the particle electric field are found to oscillate slowly with a period of oscillation of particles trapped in the potential trough of the driving wave. Analogous spatial oscillations have been reported by Malmberg and Wharton. The physical system represented in these calculations is similar to the experiment of Decker and Hirshfield in which a series of disks with alternating potential is set up perpendicular to the axis of a plasma column. In the second situation, the external source charge density is held constant and represents a small sinusoidal inhomogeneity in the ion background. The appropriate Bernstein, Greene, and Kruskal equilibrium is calculated and found numerically to be stable against small perturbations. Landau damping rates for perturbations from these inhomogeneous equilibria are compared with the values calculated by Jackson and Raether. In another calculation the inhomogeneity in the background charge density is varied slowly compared with the electron plasma frequency to simulate the field seen by electrons in the presence of an ion–acoustic wave. This is done to test the common assumption that in the presence of an ion wave the mobile electrons respond in such a way as to obey a locally isothermal equation of state. In the cases calculated the electrons do obey an isothermal equation of state to within a few percent. In the fourth situation the ion inhomogeneity is switched on suddenly with the electrons initially in a uniform equilibrium. The electrons redistribute themselves to screen out the ion field, and if the inhomogeneity is not too large, they approach an inhomogeneous equilibrium by Landau damping. (Diss. Abstr.)

12862 DYNAMIC INTERACTION OF A PLASMOID WITH A MAGNETOSTATIC FIELD GRADIENT FROM AN AXIAL CURRENT. Deshmukh, Ashok Rajeshwar. Hoboken, N. J., Stevens Inst. of Tech., 1968. 95p.

Thesis.

The dynamic behavior of a plasmoid in a magnetostatic field having a gradient is investigated. The plasmoid is produced by a Bostick-type twin-electrode button source and the azimuthally symmetric magnetostatic field with a 1/r dependence is produced by an axial current of up to 48 kA. The motion of such a plasmoid projected in the transverse-to-B plane and in the direction of increasing field, is studied. The plasmoid motion is resolved into a motion in the plane transverse-to-B, and a motion along the field lines. The experimental observations reveal that in the transverse plane the plasmoid penetrates across the field lines while experiencing radial deceleration in its bulk (fluid) velocity, and a drift along the axial direction. The radial component of the fluid velocity of this plasma eventually reduces to zero at a turning point; the plasmoid then reverses its radial direction of motion and travels away from the axial current. Concurrently, the plasma spreads along the azimuthal field lines and drifts axially in the direction opposite to that of the axial drift of the plasma in the transverse plane. This plasma also forms a plasma-field interface cavity surrounding the axial current, and its boundary lies at the radial position of the turning point of the trajectory of the plasma in the transverse plane. An analytical treatment is presented to describe this behavior of the plasmoid. Using the theory of the guiding-center approximation, an equation to the trajectory of the plasma in the transverse plane is derived. It is, however, found that an analytical model based on the $\vec{J} \times \vec{B}$ forces, due to the depolarizing currents flowing in both parts of the plasma, is more successful in explaining the entire observed motion of the plasma. The theoretical trajectories for a few situations are presented and their agreement with the observed trajectories is satisfactory within the limitations of the experiment. (Diss. Abstr.)

12863 EQUATIONS OF THE ELECTROMAGNETIC FIELD CONTAINING PLASMA. Karlovitz, Bela (Combustion and Explosives Research Inc., Pittsburgh). Nucl. Fusion, 8: 319-22(Dec. 1968).

Plasma differs from all other media in the nature of its diamagnetic moment. The motion of the free ions and electrons, responsible for the magnetic moment of the plasma, is not restricted by quantum rules. Consequently, the energy transfer mode $c\vec{E} \cdot \mathrm{curl}\ \vec{M}$, which is forbidden by Maxwell's equations for all other media, does exist between plasma and field. Full description of an electromagnetic field containing plasma therefore requires additional terms in the field equations. These terms allow the existence of a new phenomenon: the generation of steady-state electrical vortex fields measured in a coordinate system at rest relative to the time-constant magnetic field. The characteristic properties of this plasma-generated induction phenomenon are described briefly. The need for an experimental test of the predicted phenomenon is stressed, particularly in view of the great simplifications it may offer for the realization of thermonuclear power. (auth)

12864 ELECTRICAL CHARACTERISTICS OF A LOW-PRESSURE SLEPIAN DISCHARGE ROTATING MAGNETOPLASMA WITH A PENNING DISCHARGE RADIAL ION SOURCE. Rikoski, Richard Anthony. Pittsburgh, Carnegie–Mellon Univ., 1968. 122p.

Thesis.

The low-pressure Slepian discharge rotating magnetoplasma has been investigated in helium for neutral gas pressures of 3.3×10^{-1} and 6.7×10^{-2} torr with applied end wall potentials to +300 volts dc and an applied axial magnetic field of 0 to 6000 gauss. A Penning discharge radial ion source with cold cathodes and cathode-anode current capability of 500 mA is incorporated as a central ion source within the Slepian discharge apparatus. Electrical characteristics for the ionizer have been measured for pressures of 10, 5, 1, 10^{-1}, 10^{-2} and 10^{-3} torr. These include graphical presentations of V/I, V/d, V/B, I/d and I/B. Terminal electrode characteristics have been measured in the Slepian discharge including radial and axial currents as functions of a variety of discharge electrical and physical parameters. For pressures of 3.3×10^{-1} and 6.7×10^{-2} torr, anomalous diffusion effects were not observed. Minima in end wall current were recorded for certain values of arc current and magnetic field. Using data from previous high-pressure Slepian discharge experiments, a relationship between end current minimum and electron temperature enhancement is shown. End current minima five times as great as those previously observed have been found in the low-pressure Slepian discharge. Thus it has been concluded that a higher degree of thermal enhancement is present in this discharge than that found in previous experiments of this type. Future investigations are suggested and a Penning discharge radial ion source using Glascock-type heated cathodes has been designed for incorporation into an ultra-low-pressure Slepian discharge experiment. (Diss. Abstr.)

12865 RESONANCE LOADING FOR BOUND PLASMAS. Skipping, Clifton Ray. Austin, Tex., Univ. of Texas, 1968. 163p.

Thesis.

Using the solution to the electric field wave equation the resistive loading of an rf power source inductively coupled to a magnetized plasma cylinder is computed. Both the coupling coil and the plasma are of finite length, the latter having conducting wall boundaries at each end. By solving a boundary value problem complete expressions for the electric field components in the plasma and vacuum regions are obtained. Collisional damping of the plasma wave is considered and electron inertia is included. The axial dependence of the electric field is determined by Fourier series solutions and because of the nonzero electron mass the computation of the Fourier coefficients takes both roots of the dispersion relation into account. The loading-resistance behavior in the neighborhood of the lower hybrid resonance is investigated and results of numerical computations are given. For this resonance the nature of resistive loading under the influence of both dispersion relation roots and several Fourier contributions for a finite system is more thoroughly revealed than in past treatments. In many cases the nonresonant root of the dispersion relation is found to have a considerable effect on the loading resistance. The other root (containing the lower hybrid resonance) alone accounts for resonant loading behavior only in special cases. Results also show that reasonable approximation of the loading resistance often requires use of several higher-order Fourier terms. (Diss. Abstr.)

Production

Refer also to abstract 12765.

12866 (CEA-CONF-1205) TEMPERATURE IN LASER-CREATED DEUTERIUM PLASMAS. Bobin, J. L.; Delobeau, F.;

de Giovanni, G.; Fauquignon, C.; Floux, F. (Commissariat a l'Energie Atomique, Villeneuve-Saint-Georges (France)). [1968]. 27p. (CONF-681112-3). Dep.

From Annual Meeting of the Division of Plasma Physics, Miami Beach, Fla.

Laser light interaction on massive solid-state deuterium targets was used. The experiment is a rather complicated one. It involves a powerful neodymium glass laser, sharp focusing, and a cryogenic setup. Only two diagnostic techniques are commonly used: streak recording of the plasma time history (fortunately, deuterium ice is a transparent material); and electron temperature measurements by means of x-ray absorption. Theoretical investigations were also undertaken, using a simplified hydrodynamical model. Obviously, the model involves many more parameters than could actually be measured. However, agreement between prediction and experimental results appears satisfactory. (auth)

12867 (NP-17746) PLANAR PLASMA SOURCE. Preprint No. 129. Gol'ts, E. Ya.; Turundaevskii, V. B.; Khodzhaev, A. Z. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 20p. (In Russian). Dep.

Descriptions are given of a plasma source in which the discharge passed along an organic glass surface (≈ 1 cm^2). The plasma jet formed in shorter time than the half-cycle of current in the source. The regularities of space–time distribution of the plasma jet density n_{max} as a function of the intensity and magnitude of the source capacitance were investigated. The accelerated plasma clusters (of certain length and of high hydrogen purity) were obtained by plasma jet cutoff by means of the planar source. In such a source the discharge takes place between two molybdenum electrodes along the organic glass plane. During measurements the negative electrode was grounded, the electric pulse initiating the discharge between electrodes was of negative polarity, and the vacuum was not below 2×10^{-6} torr. (R.V.J.)

12868 (NP-tr-1726) PLASMA FORMATION FROM PARTICLES OF CONDENSED MATTER. Prevot, F.; Coutant, J. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Culham Lab., Abingdon, Eng., from S.R.A.C.P. report. 21p. (CTO-513).

The possibility is investigated of forming a high-temperature plasma from particles of condensed matter. The existence of a lower limit for the size of an electrically charged solid particle is indicated. It is shown that the acceleration and ionization of particles of near-limiting size is possible under favorable conditions for the formation of a very high-temperature plasma. (auth)

12869 THE ORIGIN OF THE PLASMA IN AN ELECTROMAGNETIC SHOCK TUBE. Fearn, D. G. (Imperial Coll. of Science and Tech., London). J. Plasma Phys., 2: 93-101(Feb. 1968).

A pair of electrodes was placed in an electromagnetic shock tube to measure the electric field induced by the flow of an argon plasma through a transverse magnetic field. This investigation suggested that the plasma consisted of two regions, the first of which was nonluminous. Flow velocities, deduced from the variation of induced voltage with electrode separation, were compared with luminous front velocities measured photoelectrically. The first plasma region moved more slowly than the second, and its velocity and duration were consistent with shock-heating. The second region, which was dominant in most experiments, flowed at the luminous front velocity, and had probably been ejected from the driver discharge. It is proposed that the flow velocity in the second region exceeded that in the first owing to an extensive leakage of gas through the boundary layer at the contact surface. (auth)

12870 IONIZING DETONATION WAVES IN TRANSVERSE ELECTROMAGNETIC FIELDS. Gordon, A. R.; Helliwell, J. B. (Univ. of Strathclyde, Glasgow). J. Plasma Phys., 1: 219-28 (May 1967).

A simple model of an ionizing detonation wave is studied in which the electrical conductivity jumps from zero to infinity across the wave at which a net release of exothermal energy occurs and which propagates with magnetoacoustic speed relative to the products of combustion. The upstream electric and magnetic fields are mutually orthogonal and transverse to the direction of propagation. The ratios of downstream flow parameters to those upstream and the detonation speed are presented for a range of values of the upstream electromagnetic field. It is surmised that, for a specified upstream magnetic field, physically realistic detonation waves exist only for a limited range of values of the electric field strength of invariant sign. (auth)

12871 EXPANSION ANISOTROPY OF LASER-PRODUCED PLASMAS. Gorog, I. (Laboratories Gas Ionizzati, Frascati, Italy. European Space Research Inst., Frascati, Italy). Phys. Lett., 28A: 371-2(Dec. 16, 1968).

The expansion anisotropy of laser-produced plasmas is interpreted in terms of a drifting and expanding sphere model. Analytical expressions for particle velocities, currents, and time-integrated counts are given. The theoretical expressions are compared with experimental results. (auth)

Stability

Refer also to abstracts 12780, 12852, 12922, and 12931.

12872 (NP-17748) THEORY OF EQUILIBRIUM AND STABILITY OF HIGH-CURRENT SELF-COMPRESSED DISCHARGE IN OPTICALLY DENSE PLASMA WITH RADIATIVE THERMAL CONDUCTIVITY. Preprint No. 168. Rukhadze, A. A.; Triger, S. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 79p. (In Russian). Dep.

A theoretical analysis is given of the equilibrium and stability of a high-current pulsed discharge in optically dense plasma of strong radiant thermal conductance. Cases of simple cylindrical discharge (Z pinch) and inverse axial current discharge (inverse pinch) were studied. Increments of screw- and kink-type instabilities were calculated for high- and low-conducting plasma. Discharge parameters for a continuous discharge stability necessary when used as a source of light were determined. Problems of unsteady discharge are discussed and the time required for establishing equilibrium in the discharge was evaluated. (tr-auth)

12873 (NP-17760) HYDRODYNAMIC THEORY OF STABILITY OF LAMINAR FLOW OF DENSE PLASMA. Baikov, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 21p. (In Russian). Dep.

Stability of a dense inhomogeneous plasma flowing along a strong magnetic field at varying velocities was studied, using a two-liquid hydrodynamic model. A dispersion equation for determining the spectrum of the small potential of plasma oscillations was obtained within the approximation limits of geometric optics. It was shown that, in the presence of phase resonance between the flow rate and acoustic or drift waves in a dense plasma with a large number of collisions, low-frequency instabilities were induced by the flow-rate gradient increase. The increases of these instabilities are capable of significantly exceeding the plasma drift frequencies. The influence of the finite thermal conductivity and plasma viscosity on the increase of oscillations was analyzed. At large flow rate gradients such instabilities are not stabilized by the weak crossing of magnetic field lines and, therefore, they present a serious danger to the problem of magnetic confinement of plasma flow and may induce flow turbulence at a rate below the Alfvén rate of flow. (R.V.J.)

12874 KELVIN–HELMHOLTZ INSTABILITY FOR A COLLISIONLESS PLASMA MODEL. Smith, Craig G.; von Goeler, S. (Princeton Univ., N. J.). Phys. Fluids, 11: 2665-8(Dec. 1968).

The dispersion relation of the Kelvin–Helmholtz instability due to a shear in ion fluid velocity parallel to the magnetic field is calculated from the Vlasov equation to account for effects of ion Landau damping and finite Larmor radius. Due to the relatively short wavelength parallel to the magnetic field, resonant particle effects are strong and the dispersion relation is considerably modified from that obtained by D'Angelo with a fluid treatment. (auth)

12875 NONLINEAR DEVELOPMENT OF THE TWO-STREAM INSTABILITY. Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.); Armstrong, T. P. Phys. Fluids, 11: 2669-79(Dec. 1968).

The nonlinear development of the two-stream instability is investigated analytically and numerically using as a model two cold interpenetrating electron and ion streams. When periodic boundary conditions are chosen so that only one linearly unstable wave is excited, it is found that whether or not the instability levels off nonlinearly before overtaking is directly dependent upon the choice of the spatially averaged electric field E_0. Simple choices of E_0 are given for stabilization and no stabilization. Also, even though there is strong nonlinear coupling, there is no continuous flow of energy into higher harmonics, for those waves which stabilize. (auth)

12876 NONLINEAR THEORY OF LOW-FREQUENCY INSTABILITIES. Dupree, Thomas H. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 2680-94(Dec. 1968).

It is proposed that the dominant nonlinear effect of low-frequency instabilities is an incoherent scattering of particle orbits by waves. The scattering is considered to be incoherent even when only a single mode is present. Because it is incoherent, one can include wave scattering in the theory just as collisional scattering is included in the linear wave theory. A nonlinear dispersion relation is obtained from the linear dispersion relation simply by adding wave scattering terms to the collisional scattering terms. The wave scattering causes particle diffusion over the transverse wavelength and in the theory appears as an enhanced viscosity. This wave induced viscosity can be computed from the amplitude of the wave. Waves which are linearly unstable grow until the enhanced scattering causes their nonlinear growth rates to vanish. Theoretically computed values of density fluctuations, phase shifts, and flux are in good agreement with experimental values in the cases considered. (auth)

12877 FLUID EQUATIONS FOR A COLLISIONLESS PLASMA INCLUDING FINITE ION LARMOR RADIUS AND FINITE β EFFECTS. Bowers, E.; Haines, M. G. (Imperial Coll. of Science and Tech., London). Phys. Fluids, 11: 2695-2708(Dec. 1968).

The distribution function is systematically expanded in the finite Larmor radius ordering scheme for a collisionless plasma in an axial magnetic field $B_z(x,y,t)$, where the magnetic field variation is a direct result of finite plasma pressure ($\beta \sim 1$). Fluid equations are evaluated in both the guiding-center frame and the center-of-mass frame. These equations are complicated by the velocity dependent ∇B drift which prevents strict closure of the moment equations. The effect of finite β is to include further terms in the stress tensor and in the energy equation in the form of a heat flux. An alternative derivation by a direct moment expansion is included. From these fluid equations the mechanism for producing radial differential rotation is rigorously shown. Secondly the stability of a rotating theta pinch is studied showing two finite β effects which can contribute to stability. The first is due to the increase in diamagnetic angular velocity (a result of creating a magnetic well) and the second due to the azimuthal equilibrium heat flow if the ion temperature decreases with radius. (auth)

12878 ELECTROMAGNETIC MICROINSTABILITIES OF PLASMAS IN A UNIFORM MAGNETIC INDUCTION. Hamasaki, Seishi (Univ. of Wisconsin, Madison). Phys. Fluids, 11: 2724-7(Dec. 1968).

Electromagnetic instabilities associated with transverse plasma waves propagating perpendicular to an external uniform magnetic induction B_0, are investigated for a two-temperature Maxwellian distribution function. The analysis shows that no instability develops if $V_{\|e}^2 < V_{\perp e}^2$ where $V_{\|e}^2$ and $V_{\perp e}^2$ are the electron temperatures parallel and perpendicular to B_0. For $V_{\|e}^2 > V_{\perp e}^2$ an instability develops if $\omega_{ce}^2/\omega_{pe}^2 < V_{\|e}^2/c^2[1 - (3/2)^{1/2}(V_{\perp e}/V_{\|e})]$; where ω_{ce} and ω_{pe} are the cyclotron and plasma frequency, respectively, and c is the velocity of light. The allowable frequency regions for this type of electromagnetic wave to exist across B_0 are studied. It is found that below the plasma frequency there is always a narrow allowable frequency band just below any harmonics of the ion or electron cyclotron frequencies. Each width of the allowable frequency band is calculated. (auth)

12879 HYDROMAGNETIC STABILITY OF SYMMETRIC PLASMA CONFIGURATIONS. Zueva, N. M.; Solov'ev, L. S. At. Energ. (USSR), 26: 35-43(Jan. 1969). In Russian).

A general geometrical criterion for the equilibrium plasma stability is transformed for the helical symmetry. Stability of a helical plasma tube with the longitudinal current is investigated in the vicinity of the helical magnetic axis. The stability of the toroidal plasma configuration with the ring magnetic axis is also considered as a limited case. It is shown that the plasma stability and, in particular, the maximum permissible density of the longitudinal current essentially depend on the curvature and twisting of the magnetic axis, on the ellipticity and nonsymmetry of the cross sectional profile of the plasma boundary surface, as well as on the pressure. If the ellipse is flattened out along the main normal towards the magnetic axis the stability improves in case there is a sharpening of the profile in the direction from the curvature center of the magnetic axis. If the ellipse is stretched along the main normal the stability is improved when the profile is sharpened in the opposite direction. In the case of the circular cross section, the stability is independent neither of the nonsymmetry parameter nor of the plasma pressure. In general case the stability can be improved when the plasma pressure and screw pitch of the magnetic axis are decreased. The latter relates also to the case when there is no longitudinal current in the plasma. The stability areas are shown in the pictures. The helical configuration of the plasma considered above is suggested as a closed-configuration model whose magnetic axis is a spiral wound on a torus. (auth)

12880 RAYLEIGH–TAYLOR PROBLEM FOR A HALL PLASMA. Hosking, R. J. (Flinders Univ., Australia). J. Plasma Phys., 2: 613-16(Dec. 1968).

Recent calculations for hydromagnetic analogues of the classical Rayleigh–Taylor problem with Hall effect are compared. It is shown that an early calculation is the limiting situation of the work of Talwar & Kalra, which confirms that the Hall effect introduces new instabilities. (auth)

12881 SLIPPING STREAM INSTABILITY IN ANISOTROPIC PLASMA WITH MAGNETIC SHEAR. Rao, S. S.; Kalra, G. L.; Talwar, S. P. (Univ. of Delhi). J. Plasma Phys., 2: 181-7 (June 1968).

Starting with the Chew, Goldberger & Low equations, an analysis is made of instability arising due to a tangential velocity discontinuity in a dilute plasma. The velocities on either side are parallel but oppositely directed. Two cases are considered: (i) the magnetic field is uniform and everywhere transverse to the motion, and (ii) the magnetic field vectors on either side are orthogonal, being parallel to the motion on one side and perpendicular on the other. The conditions for instability are obtained and it is found that the effect of magnetic field is destabilizing in both cases. The effect of orthogonality of magnetic fields on the conventional firehose instability for a uniform, static plasma is also discussed as a special case. (auth)

12882 STABILITY OF AN ANISOTROPIC RELATIVISTIC PLASMA IN A MAGNETIC FIELD. Skilling, J. (Mullard Radio Astronomy Observatory, Cambridge, Mass.). J. Plasma Phys., 2: 157-65(June 1968).

The collisionless relativistic Boltzmann equation is used to investigate the stability of a large-scale two-component plasma containing numerically small anisotropic relativistic populations. Although most permitted waves are stable, Alfvén type waves are found to be unstable whenever the anisotropy exceeds $O(v_A/c)$. Growth times are estimated as days for supernova remnants and millennia for cosmic-ray protons. (auth)

12883 A NOTE ON THE TWO-STREAM INSTABILITY. Clemmow, P. C. (Univ. of Cambridge, Eng.). J. Plasma Phys., 2: 85-91(Feb. 1968).

Conditions for the instability of longitudinal waves in a single-component two-stream plasma, in which the streams have the same velocity spread, are given in the form of simple relations between the density ratio and the mean velocity difference of the streams. (auth)

12884 ASYMPTOTIC STATE OF THE TWO-STREAM INSTABILITY. Armstrong, Thomas; Montgomery, David (Univ. of Iowa, Iowa City). J. Plasma Phys., 1: 425-33(Nov. 1967).

Previously reported numerical investigations of the nonlinear Vlasov equation are extended to an intensive study of the two-stream instability. Strongly unstable initial conditions for the one-dimensional electron plasma are followed in time until the state of the plasma has become essentially time independent. Both the electric field and the distribution function appear to be characteristic of an inhomogeneous equilibrium. (auth)

12885 ON THE PROPAGATION OF CYLINDRICAL WAVES IN A MAGNETIZED SELF-GRAVITATING COLLISIONLESS PLASMA. Mattei, Giulio (Univ., Pisa, Italy). J. Plasma Phys., 2: 9-15(Feb. 1968).

Solutions are obtained for cylindrical waves of the equations governing a magnetized self-gravitating collisionless plasma. Subject to certain conditions, two types of instability were found: (i) the hose instability which is related to the anisotropic pressure; and (ii) gravitational instability. (auth)

12886 MINIMUM-AVERAGE-B STABILIZATION FOR TORUSES. Furth, H. P. (Princton Univ., N. J.). Advan. Plasma Phys., 1: 67-100(1968).

The following topics are reviewed: (1) conditions for expecting improved stability with minimum-average-B, (2) some exact definitions of what is meant by minimum-average-B in various contexts, (3) the main types of minimum-average-B configuration that have been studied, (4) some initial experimental results, and (5) the prospects, as they appear at present, of utilizing minimum-average-B stabilization in controlled-fusion research. (M.O.W.)

12887 RESISTIVE INTERCHANGES AND THE NEGATIVE V'' CRITERION. Johnson, J. L.; Greene, J. M. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Plasma Phys., 9: 611-29(1967). (MATT-489).

A natural co-ordinate system in which the current and magnetic field lines are straight is utilized to study localized hydromagnetic interchange instabilities in general toroidal configurations. This provides a clarification of the nature of the energy sources which are available to drive the instability and of the constraints which the perturbation must satisfy. An analysis in which the electrical resistivity is small but nonzero is made. This provides a reasonable generalization of the V'' criterion for average-minimum-B systems and shows that if the condition is satisfied then purely growing instabilities cannot grow as fast as $\eta^{1/3}$ in the limit of small resistivity. (auth)

12888 FLUTE INSTABILITY IN AN AXIALLY SYMMETRIC PLASMA WITH FINITE ION LARMOR RADIUS. Dnestrovskii, Yu. N.; Kostomarov, D. P.; Suzdaltseva, L. F. (Moscow State Univ.). Nucl. Fusion, 8: 341-50(Dec. 1968).

Solving numerically the integro–differential equation for plasma oscillations, the authors study the effect of the size of the ion Larmor radius r_i and of an intrinsic electric field on the flute instability of a plasma. It is shown that, in a dilute plasma ($\omega_{0i}^2/\omega_i^2 \ll 1$, where ω_{0i} and ω_i are the plasma and Larmor frequencies of the ions), effects attributable to the finiteness of r_i are small and cannot explain the stabilization of oscillations in the Phoenix device. Intrinsic electric fields due to an excess of ions improve the stability of such a plasma. If the magnetic field gradient is small ($aH'/H \sim 0.1$, where a is the characteristic dimension of the plasma) and the Larmor radius is of reasonable size ($r_i \sim 0.2a$), a relatively dense plasma ($\omega_{0i}^2/\omega_i^2 \sim 10$) surrounded by a conducting sheath may be stable. (auth)

12889 INFLUENCE OF BALLOONING EFFECTS ON PLASMA STABILITY IN CLOSED SYSTEMS. Shafranov, V. D.; Yurchenko, E. I. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 8: 329-39(Dec. 1968).

A general criterion of hydromagnetic plasma stability in the infinite electrical conductivity approximation is applied to smooth closed systems. As in the pioneering work of Mercier, the authors use the method of expansion with respect to the deviation from the magnetic axis. The effects of ballooning instability and of magnetic well deepening due to ballooning-induced stretching of the plasma column are clearly distinguished in this criterion. The above effects cancel out with an accuracy to within the square of the ellipticity of the magnetic surface cross sections. Even in magnetic systems with a comparatively shallow magnetic well, ballooning instability does not, therefore, lead to a serious limitation on plasma pressure. Estimates are presented of the critical plasma pressure for a two-turn stellarator and for systems with helical and axial symmetry. (auth)

12890 KINETIC INSTABILITY OF FLUTE OSCILLATIONS. Kopecky, V. (Inst. of Plasma Physics, Prague). Nucl. Fusion, 8: 313-17Dec. 1968).

The effect of resonance particles drifting under the influence of magnetic field inhomogeneity with a velocity close to the phase velocity of flute oscillations on those oscillations is considered. The instability of these oscillations is studied at densities below the critical density of the hydrodynamic flute instability $Ra/d^2 \ll 1$ (R is radius of curvature of the magnetic field lines, a is transverse dimension of the plasma, d is Debye radius). It is shown that, when resonance particles are present, the branch of oscillations with frequency $\omega = -\omega_0^2/\omega_c ka$ (ω_0 is ionic plasma frequency, ω_c is ionic cyclotron frequency, k is transverse wave number) is always unstable. For an ion transverse velocity distribution function having the form of a δ function with an admixture of hot ions, it is shown that the branch of oscillations with a frequency only slightly dependent on density and close to $-kv_0^2/2R\omega_c$ (v_0 is mean ion velocity) is also unstable. Both instabilities also occur in the hydrodynamically stable case; i.e., when the magnetic field lines are convex with respect to the plasma. (auth)

12891 MAGNETOGRAVITATIONAL INSTABILITY OF A VLASOV PLASMA. Bajaj, N. K.; Tandon, J. N. (Univ. of Delhi). Nucl. Fusion, 8: 297-312(Dec. 1968).

A complete derivation of the moment equations of a Vlasov plasma is presented separately for the three density domains, namely the high-density regime ($b \rightarrow 0$), the moderate-density regime [$b\epsilon \approx O(1)$] and the low-density regime [$b\epsilon^2 \approx O(1)$] with b as the ratio of Alfvén velocity to light velocity and $\epsilon = a/L$ where a is the ion Larmor radius and L, the characteristic length of the system. These moment equations are then employed to investigate the effect of finite β (= particle pressure/magnetic pressure) on gravitational flute instability of a nonuniform plasma. It is shown that the effect of finite β is one of stabilization. (auth)

12892 ENTROPY AND STABILITY OF PLASMA EQUILIBRIUM CONFIGURATIONS. Minardi, E.; Santini, F. (EURATOM-FOM Association, Jutphaas, Netherlands). Physica, 33: 439-72(1967).

The definition of the entropy functional introduced in preceding articles and the related variational techniques are extended and applied to the characterization of the equilibrium and stability properties of many plasma configurations of practical interest. The entropy functional is minimum at equilibrium with respect to a large class of unstable modes, that is low frequency modes or high-frequency nearly electrostatic modes which are initially zero at the boundaries of the plasma. Moreover, the minimum of the entropy can be connected with a negative variation of the electric and magnetic energy in a special class of interchanges. Known sufficient instability conditions prove to be the same as minimum conditions for the entropy. This is explicitly shown for the purely electrostatic micro-instabilities, the flutes, the shear instability, and the unstable mirror-type modes in plane or cylindrical geometry. Finally, the conditions for a maximum entropy of a low-β plasma equilibrium in a general adiabatic magnetic field configuration are discussed. A nonzero minimum-B configuration can satisfy these conditions, but for a plasma with a low but nonzero β other restrictions have to be imposed on the plasma pressure and on the magnetic field as functions of space. (auth)

Thermonuclear Processes

12893 (NP-17759) ATTENUATOR BASED ON A FERRITE RESONANCE SWITCH. Preprint No. 74. Tsopp, L. E. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1968. 7p. (In Russian), Dep.

Theoretical concepts and experimental characteristics are given for a ferrite switch used as a dissipative plasma attenuator in the Ramus II (R-II) device. Graphical data show that by varying the intensity and direction of the magnetic field the attenuation can vary from minimum to maximum magnitudes; installation of a second switch in a waveguide circuit, adjusted to the resonance, by switching to the current in the electromagnet was capable of regulating the damping in the circuit from 0 to 45 db. It is also shown that an installation of series-connected attenuators could achieve the attenuation up to 100 db and over. (R.V.J.)

Wave Phenomena

Refer also to abstracts 12667, 12876, and 12885.

12894 WEAK TURBULENCE THEORY OF VELOCITY SPACE DIFFUSION AND THE NONLINEAR LANDAU DAMPING OF WAVES. Manheimer, Wallace M.; Dupree, Thomas H. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 11: 2709-23(Dec. 1968).

The particle–wave interaction to arbitrary order in perturbation theory is investigated. One finds that to every order the ensemble average distribution function obeys a diffusion equation. The diffusion constant specifies how the energy and momentum of particles change in time. By conservation of energy and momentum between waves and particles, the growth or damping rates of waves to any order can be determined. The growth rates for nonlinear instabilities and the damping rates for nonlinear Landau damping are explicitly calculated. (auth)

12895 MICROWAVE SCATTERING FROM PLASMA WAVES. Wharton, C. B.; Malmberg, J. H. (Gulf General Atomic, Inc., San Diego, Calif.). Phys. Fluids, 11: 2655-64(Dec. 1968).

Experimental studies of the scattering of electromagnetic waves (34 GHz) from longitudinal plasma waves (250 to 500 MHz) are described. The plasma waves propagate in a 230-cm-long collisionless plasma column, having an electron density on axis of $n_{e0} = 2.7 \times 10^9$ cm^{-3} and an electron temperature $T_e \approx 13$ eV. Scattering was observed both from plasma waves launched by a probe antenna and from waves grown up to a nonlinear saturation out of the white noise background by resonant interaction with an electron beam. The properties of these waves are accurately determined by auxiliary measurement. By using movable antennas one was able to measure the spatial growth and damping coefficients of plasma waves and to measure their absolute amplitudes. The microwave scattering is observed at a frequency displaced from the microwave frequency by the plasma wave frequency, and at an angle related to the Bragg angle. The measured frequency spectrum, angular dependence, and scattering amplitudes are compared with the theory and with rf probe measurements, giving excellent agreement in all cases. (auth)

12896 QUASILINEAR THEORY OF HYDROMAGNETIC WAVES IN COLLISIONLESS PLASMA. Barnes, Aaron (Ames Research Center, Moffett Field, Calif.). Phys. Fluids, 11: 2644-54(Dec. 1968).

A quasilinear theory of hydromagnetic waves in nonrelativistic collisionless plasma (with no super-thermal "tail") is derived. It is shown that the time evolution of the space-averaged velocity distribution function of each species is described by a diffusion equation in velocity space, and that this "diffusion" can be split into resonant and nonresonant parts. The resonant diffusion determines the heating of the (finite-β) plasma by damping hydromagnetic waves; such heating enhances electron and ion kinetic temperatures parallel to the average magnetic field, and does not affect transverse temperatures. Quasi-linear quenching of the hose instability is discussed as an example. (auth)

12897 LONGITUDINAL WAVE PROPAGATION IN VISCOUS FULLY IONIZED PLASMAS. Kahn, David (Electronics Research Center, Cambridge, Mass.). Phys. Fluids, 11: 2635-43(Dec. 1968).

A collisional theory of wave propagation in two fluid fully ionized gases is formulated from the coupled set of Maxwell and Boltzmann equations for an investigation of the collisional damping and dispersion of electron and ion waves. The electron and ion velocity distribution functions of the Boltzmann equations are expanded in Sonine polynomials to an order that gives the collision integrals for the electron and ion self-interactions as well as for the electron–ion interactions. This approximation permits the determination of viscous as well as friction-caused electron and ion wave attenuation and dispersion. It is found that the inclusion of the self-interaction integrals (viscous terms) leads to values of the attenuation and dispersion functions which are substantially different quantitatively (and in some frequency regimes, also qualitatively) from the values obtained previously without these terms. (Major ion wave damping, for example, occurs when the wave and ion–ion collision frequencies are comparable, a result not obtainable from the inviscid theory.) The attenuation and dispersion functions are numerically (and in several limiting cases of interest, analytically) evaluated as functions of the self- and interparticle collision to wave frequency ratios and as functions of the plasma to wave frequency ratios for several different plasmas characterized by different collision to plasma frequency ratios. (auth)

12898 WAVE COUPLING ACROSS A DENSITY DISCONTINUITY IN A MAGNETIZED PLASMA. **Morin, Stephen; Kahn, David (Electronics Research Center, Cambridge, Mass.). Phys. Fluids, 11: 2627-34(Dec. 1968).**

The plane-wave solutions of the linearized hydrodynamic equations and Maxwell's equations for a fully ionized plasma are used to investigate the properties of plasma oscillation modes which propagate perpendicular to an external magnetic field. Energy conversion among these modes at a density discontinuity separating two semi-infinite plasmas is investigated. Numerical results illustrate the variations of various energy coupling efficiencies with angle of incidence, propagation frequency, and magnetic field intensity. In contrast to the field-free case previously considered, it is found that energy conversion occurs among all of the plasma modes for normally incident waves. Very high efficiencies of energy conversion between field-modified electron and transverse waves for propagation frequencies below the hybrid frequency $(\omega_e^2 + \omega_B{}^2)^{1/2}$ where ω_e and ω_B are, respectively, the electron plasma frequency and the electron cyclotron frequency are also found. (auth)

12899 HYDROMAGNETIC WAVES IN A NONUNIFORM HYDROGEN PLASMA. **Cross, R. C.; Lehane, J. A. (Univ. of Sydney). Phys. Fluids, 11: 2621-6(Dec. 1968).**

The propagation of azimuthally symmetric Alfvén waves in a cylindrical hydrogen plasma with a nonuniform density distribution is investigated theoretically and experimentally. Dispersion relations are derived for the case of a fully ionized plasma with a radial density gradient and are shown to describe some of the experimental features which are not predicted by a uniform plasma theory. Experimental results are presented for both torsional and compressional Alfvén waves propagating in one and the same plasma. It is shown that the torsional Alfvén wave propagates at a radially varying speed which agrees well with the local Alfvén speed deduced from the local particle density. Compressional Alfvén waves are shown to be planar and at high frequencies to be confined largely to the center of the plasma column due to a refraction of the wave produced by the density gradient. The use of uniform plasma theory to obtain estimates of plasma parameters from the study of compressional waves leads to values different from those obtained from the study of torsional waves. This difference is explained in terms of the radial density gradient in the plasma. (auth)

12900 HELICON WAVES IN NON-RESISTIVE CYLINDRICAL AND SPHERICAL PLASMAS. **Francey, J. L. A.; Gates, D. J. (Monash Univ., Victoria, Australia). J. Phys., A (London), 1: 710-22(Nov. 1968).**

A theoretical discussion of helicon wave propagation in nonresistive plasmas is presented. The boundary conditions are derived and applied in cylindrical geometry to give results consistent with experiment. The problem is more complicated in spherical geometry because of the nonseparability of the wave equation. However, by separating in cylindrical coordinates and rearranging in a series of spherical waves, solutions are obtained in the form of an infinite set of integral equations. Approximate solutions are obtained and the first few natural frequencies are identified. Wave fields for the principal mode are calculated and displayed graphically. (auth) (UK)

12901 TRANSPORT EQUATION FOR THE MULTIPLE SCATTERING OF ELECTROMAGNETIC WAVES BY A TURBULENT PLASMA. **Stott, P. E. (Culham Lab., Abingdon, Eng.). J. Phys., A (London), 1: 675-90(Nov. 1968).**

Calculations of the scattering of electromagnetic waves by a turbulent plasma are usually based upon either a weak scattering or a random-walk approximation. The multiple scattering process is considered in this paper by a method which is independent of the magnitude of the turbulent fluctuations. A solution is obtained in the form of a transport equation whose familiar properties describe the long-range behavior of the scattering. The diffraction effects are contained in the kernel of the transport equation, which is equivalent to the scattering cross section per unit volume of the plasma. (auth) (UK)

12902 SURFACE WAVES OF A MAGNETOACTIVE PLASMA. **Jungwirth, K.; Petrzilka, V. A. (Inst. of Plasma Physics, Prague). J. Plasma Phys., 2: 73-84(Feb. 1968).**

It is proved in the surface-potential-waves approximation that, not only a bounded plasma with flows along the magnetostatic field, but also a plasma with a finite "longitudinal temperature" of the electrons can be unstable against axially asymmetric perturbations of magnetohydrodynamic type. The branches of surface oscillations of a cold plasma, and the conditions for their excitation by an admixture of electrons with a sufficiently high "longitudinal temperature" in various geometrical configurations, are also derived. (auth)

12903 STABILITY OF MAGNETOHYDRODYNAMIC SHOCK WAVES. **Lessen, Martin; Deshpande, Narayan V. (Univ. of Rochester, N. Y.). J. Plasma Phys., 1: 463-72(Nov. 1967).**

The stability of oblique magnetohydrodynamic shock waves is studied with respect of a disturbance that excites magneto-acoustic waves. The problem is solved numerically by the normal mode analysis and it is shown that slow shocks are unstable in the sense that the disturbance grows exponentially with time. Growth rates are calculated for a particular Mach number and for different values of the magnetic field and obliqueness. The fast shock appears to be stable. (auth)

12904 INTERACTION OF ELECTROMAGNETIC FIELDS WITH WARM SLIGHTLY IONIZED MAGNETOPLASMAS. **De Barbieri, O.; Maroli, C. (Univ., Milan). J. Plasma Phys., 1: 473-81(Nov. 1967).**

The problem concerning the interaction of electromagnetic fields with a warm, slightly ionized magnetoplasma is analyzed by means of the multiple-time-scales asymptotic technique. Only initial-value problems in an infinite plasma are considered in detail. It is shown how the full set of Vlasov–Maxwell equations modified through a standard Boltzmann collision integral to take account of the elastic electron–neutral encounters, can be reduced, in the basic limit assumed, to a set of two coupled nonlinear integro-differential equations for the dominant terms of the longitudinal fields and of the electron distribution function. Once the initial conditions are specified, the behavior of the transverse initial field is also described. A particular example has been given for the so-called progressing-wave initial conditions. (auth)

12905 HIGHER ORDER APPROXIMATIONS IN THE THEORY OF LONGITUDINAL PLASMA OSCILLATIONS. **Einaudi, F.; Axford, W. I. (Cornell Univ., Ithaca, N. Y.). J. Plasma Phys., 1: 483-97(Nov. 1967).**

The nonlinear behavior of one-dimensional electrostatic oscillations in a homogeneous, unbounded, collisionless and fully ionized plasma is considered for the case in which a single wave of small, but finite amplitude is excited initially. The Vlasov–Poisson equations are solved using the method of strained co-ordinates in which the independent variable t, the electric field and the distribution function are expanded in the form of asymptotic series, the terms of which are founded by an iterative procedure. An ordering parameter ϵ is introduced, which is proportional to the initial amplitude of the electric field given by linear theory. Differential equations are derived which can be solved sequentially to obtain uniformly valid solutions to all orders in ϵ. Solutions are given to second order and applied to the case in which the background distribution function is Maxwellian. It is found that the changes in the real and imaginary part of the frequency are small in comparison to the values obtained in the linear theory; that the free-streaming terms decay exponentially in time with a damping rate proportional to ϵ^2, in contrast with the linear theory where they are undamped; and that the analysis allows one to calculate the changes in the background distribution function for large time, resulting from particle–wave interactions. (auth)

12906 PROPAGATION ALONG THE MAGNETIC FIELD OF A PULSE CURRENT ORIGINATED DISTURBANCE IN A COLD TWO-FLUID PLASMA. **Lewak, G. J. (Univ. of California, La Jolla). J. Plasma Phys., 1: 435-49(Nov. 1967).**

The propagation, along the magnetic field, of a point disturbance in a cold two-fluid linear plasma is solved asymptotically in various space–time régimes. The main disturbance is a pulsed front traveling at approximately the Alfvén speed divided by the electron-to-ion mass ratio. Its profile envelope is an Airy function. It oscillates at the mean of the gyrofrequencies and is elliptically polarized. The disturbances remaining behind this front are of two kinds: an oscillation at the sum of the gyrofrequencies which is circularly polarized and represents the "extraordinary" wave, and an oscillation at the ion gyrofrequency which is elliptically polarized with changing eccentricity and orientation of axis. (auth)

12907 THE EVOLUTION OF WAVE CORRELATIONS IN UNIFORMLY TURBULENT, WEAKLY NONLINEAR SYSTEMS. Davidson, Ronald C. (Univ. of California, Berkeley). J. Plasma Phys., 1: 341-59(Aug. 1967).

A formalism is developed describing the time evolution of wave correlations in a uniformly turbulent ensemble of weakly nonlinear systems. The statistics are built into the formalism a priori. With closure (of the hierarchy of equations for wave correlations) appropriate to the inclusion of resonant three-wave interactions, a (nonlinear) kinetic equation for the two-wave correlations is derived and various properties of this equation are discussed. The effects of both bilinear and trilinear nonlinearities are considered. Modifications of the formalism in situations where there is a weak (linear) instability γ_k, ($|\gamma_k/\omega_k| \ll 1$) are also considered. (auth)

12908 PROPAGATION OF HYDROMAGNETIC WAVES THROUGH AN ANISOTROPIC PLASMA. Abraham-Shrauner, Barbara (Ames Research Center, Moffett Field, Calif.). J. Plasma Phys., 1: 361-78(Aug. 1967).

The propagation of small amplitude hydromagnetic waves of a collisionless anisotropic plasma in a strong magnetic field is treated using the Chew–Goldberger–Low (CGL) fluid equations. The Alfvén, fast and slow magnetoacoustic, and entropy modes are analyzed by phase speed and wave front diagrams and compared to their counterparts in magnetohydrodynamics (MHD) where collisions maintain an isotropic pressure. Two main classes of CGL waves are identified, pseudo-MHD and reverse-MHD where the latter has the slow wave speed greater than the Alfvén wave speed. Significant differences of the CGL hydromagnetic waves as compared to MHD waves are found which have special relevance for a study of infinitesimal and finite discontinuities in space plasmas. (auth)

12909 SHOCK JUMP CONDITIONS FOR AN ANISOTROPIC PLASMA. Abraham-Shrauner, Barbara (Ames Research Center, Moffett Field, Calif.). J. Plasma Phys., 1: 379-81(Aug. 1967).

The jump conditions for finite discontinuities in a collisionless plasma are derived in the Chew–Goldberger–Low approximation. (auth)

12910 WAVE PROPAGATION IN NONUNIFORM PLASMAS NEAR THE SECOND ELECTRON CYCLOTRON HARMONIC. Baldwin, D. E. (Yale Univ., New Haven). J. Plasma Phys., 1: 289-304(Aug. 1967).

Equations are derived which may be used to describe the propagation of electromagnetic waves in nonuniform magnetized plasma when the wave frequency is near the second electron cyclotron harmonic. The method used is to expand the linearized Vlasov equation in powers of the electron Larmor radius divided by a typical scale length. The general equations are then specialized to the problem of the coupling of transverse waves to the longitudinal modes (Bernstein modes) which exist when all quantities vary only in a plane perpendicular to a straight magnetic field. The form of these equations for two simple models of the equilibrium plasma is given. Comments are made about the equations for the higher harmonics, and the question of boundary conditions is discussed. Finally, the general equations are examined in the limit $\Omega \rightarrow 0$ in order to provide equations suitable for the description of high frequency waves in non-magnetized plasmas. (auth)

12911 PRODUCTION OF SUPERTHERMAL ELECTRONS BY ELECTROSTATIC PLASMA OSCILLATIONS. Fredricks, R. W. (Space Sciences Lab., Redondo Beach, Calif.). J. Plasma Phys., 1: 241-54(May 1967).

The beam–plasma interaction which has been proposed by Stix is examined both by approximate analysis and by integration of the nonlinear equations of motion which describe the interaction of an individual electron with a monochromatic large amplitude electrostatic plasma wave. The quasi-stochastic model of the large amplitude plasma waves, introduced by Stix (1964), has been used in the calculations by programming a random phase function into the argument of the periodic plasma wave function. It is found that electrons are subject to a quasi-cyclotron acceleration which proceeds to a higher energy in the stochastic case than the limit found in the nonstochastic case (a phase-coherent plasma wave). This behavior is interpreted in terms of a limit cycle phenomenon, and the stochastic phase shift appears to push electrons across these limit cycles. It is also found that favored groups of electrons in a 2-eV plasma excited by a 5-keV beam in a 2000-G field can achieve energies in the range 85 to 170 keV in less than a nanosecond by a single acceleration occurring in one plasma wave coherence length $L_\parallel$ as defined by Stix. (auth)

12912 PROPAGATION OF HIGH-FREQUENCY WAVES IN A PLASMA. Sharma, S. R. (Univ. of Rajasthan, Jaipur, India). Can. J. Phys., 47: 345-51(Feb. 1, 1969).

Propagation of high-frequency waves in an unbounded electron-plasma system is examined with the aid of the first three moment equations. The heat-flow tensor is neglected and the effect of collisions is taken into account through appropriate relaxation terms. Assuming an isotropic pressure in the equilibrium, it is shown that the perturbed pressure tensor shows a marked deviation from the isotropic nature if the propagation frequency is higher than the pressure relaxation frequency. A new treatment is presented for the description of transverse waves. The general dispersion relation is derived and is examined in detail for wave propagation along and perpendicular to the magnetic field. (auth) (Canada)

12913 STRUCTURE AND PROPAGATION OF IONIZING WAVE FRONTS. Turcotte, D. L. (Cornell Univ., Ithaca, N. Y.); Ong, R. S. B. J. Plasma Phys., 2: 145-55(June 1968).

A nonlinear wave propagation mechanism is found for ionization fronts. The fronts propagate due to ionizing collisions between electrons and neutrals. A parameter is obtained which specifies the amount of electrical interaction. For small electrical interaction, charge separation may occur and the front can propagate at any speed greater than a critical value. For large electrical interaction, the number densities of ions and electrons are nearly equal and a lower bound on the propagation speed is also found. (auth)

12914 PROPAGATION OF NONLINEAR WAVES IN A PLASMA IN A MAGNETIC FIELD. Freidberg, Jeffrey P. (New York Univ.). J. Plasma Phys., 2: 105-18(June 1968).

The propagation of nonlinear electromagnetic waves in a plasma is investigated by seeking traveling wave solutions to the macroscopic plasma equations. The model considered is that of a warm, anisotropic electron plasma in a magnetic field, in which the waves are allowed to propagate at any angle with respect to the magnetic field. A nonlinear dispersion relation is obtained which is valid for frequencies sufficiently close to the resonant frequencies. Traveling-wave solutions are found for all amplitudes for which the local density remains positive. Also, in sufficiently anisotropic plasmas the nature (i.e., propagating or cutoff) of one of the resonant waves can depend upon the amplitude. (auth)

12915 NYQUIST DIAGRAMS FOR LOW-FREQUENCY OSCILLATIONS IN A NONUNIFORM MAGNETOPLASMA. Bertotti, Bruno; Nocentini, Aldo (EURATOM–CNEN, Rome). J. Plasma Phys., 2: 135-43(June 1968).

A modification of the Penrose criterion is applied to the local dispersion relation for low-frequency, electrostatic instabilities in a low-density, slightly inhomogeneous magnetoplasma. The Nyquist diagrams obtained can be classified according to their behavior near the origin; this is sufficient in some cases to conclude that the equilibrium is unstable. With this method, in the limit of negligible ion Larmor radius one finds that the Langmuir waves propagating in a direction orthogonal to the external magnetic field are driven unstable by a temperature gradient. (auth)

12916 STRUCTURE OF THE BERNSTEIN MODES FOR LARGE VALUES OF THE PLASMA PARAMETER. Fredricks, R. W. (Space Sciences Lab., Redondo Beach, Calif.). J. Plasma Phys., 2: 197-206(June 1968).

The electrostatic modes for which k is perpendicular to the impressed field B_0 (the "Bernstein modes") have been examined, and dispersion curves (ω vs. k) have been calculated numerically for hybrid frequencies in the vicinity of the thirtieth to fortieth harmonic of the gyrofrequency. Although the calculations were performed for the lower hybrid case (ion branch), they also apply to the upper hybrid cases in which the plasma parameter $\omega_e^2/\Omega_e^2 \gtrsim 900$. The structure of the dispersion curves for these large values of plasma parameter differs from that for smaller values ($1 < \omega_e^2/\Omega_e^2 < 10$) investigated by others, in that broad bands in wave-number space have very small group speeds in narrow frequency bands close to many of the gyrofrequency harmonics. All of the Bernstein modes examined have group speeds less than 37% of the ion thermal speed, and can be classified as very slow waves. Furthermore, the spectrum of propagating Bernstein modes is broadened as ω_e^2/Ω_e^2 becomes large, with an effective total transmission region from the gyrofrequency up to several harmonics of gyrofrequency above the hybrid frequency. (auth)

12917 RELATIVISTIC FORMULATION FOR NONLINEAR WAVES IN A NONUNIFORM PLASMA. Butler, D. S.; Gribben, R. J. (Univ. of Strathclyde, Glasgow). J. Plasma Phys., 2: 257-81(June 1968).

The problem of using a solution for a one-dimensional wave train as a uniformly valid approximation to a slightly nonuniform wave is formulated in an invariant manner. It is then shown how, in practice, the equations obtained may be applied to the physical situation but no attempt at a solution of these equations is made here. Even for the simplest case considered, that of the nonrelativistic limit in one space dimension with no magnetic field, this would remain a formidable task. (auth)

12918 DISPERSION AND ATTENUATION OF HELICON WAVES IN A CYLINDRICAL PLASMA-FILLED WAVE-GUIDE. Ferrari, R. L. (Univ. of Cambridge, Eng.); Klozenberg, J. P. J. Plasma Phys., 2: 283-9(June 1968).

The dispersion equation for helicon waves in a plasma-filled wave-guide is derived. The relation between the solution and the quasi-static modes of Trivelpiece & Gould is discussed. An approximate dispersion relation, appropriate for cases where $\Omega_e \gg \nu \gg \omega$, is obtained allowing the real and imaginary parts of the propagation constant to be expressed very simply in a normalized form. Curves are presented for this approximation. (auth)

12919 NONLINEAR SCATTERING OF ELECTROMAGNETIC WAVES NEAR THE ION CYCLOTRON FREQUENCY IN AN INHOMOGENEOUS PLASMA. Teichmann, J. (Inst. of Plasma Physics, Prague). J. Plasma Phys., 2: 353-63(Aug. 1968).

The nonlinear induced scattering by plasma particles of right-hand and left-hand polarized electromagnetic waves propagating along the magnetic field, is studied. The nonlinear Landau damping for frequencies near the ion cyclotron frequency in a weak turbulent inhomogeneous plasma is determined. (auth)

12920 STRUCTURE OF GENERALIZED ION BERNSTEIN MODES FROM THE FULL ELECTROMAGNETIC DISPERSION RELATION. Fredricks, R. W. (Space Sciences Lab., Redondo Beach, Calif.). J. Plasma Phys., 2: 365-80(Aug. 1968).

The structure of modes for which $k \perp B_0$ and $\omega \ll \Omega_-$ (ion waves) has been studied qualitatively in the two limits $kR_+ \ll 1$ and $kR_+ \gg 1$, where $R_+ = (\kappa T_+/M\Omega_+)^{1/2}$ is the mean thermal Larmor radius, without the usual electrostatic approximation. Asymptotic forms of the dielectric tensor elements ϵ_{ij} are developed in these two limits. The modes having appreciable $k \times E$ can be called "generalized" Bernstein modes. The approximation which yields the familiar electrostatic Bernstein modes is $\epsilon_{xx} = 0$. This approximation is shown to be valid only for large kR_+ and low β. However, for small and moderate values of kR_+ the generalized Bernstein modes partake of a "mixed" electromagnetic–electrostatic character. In particular $kR_+ \lesssim O(1)$ (but $\omega/k < c$) the electrostatic Bern Bernstein modes are incorrect approximations. The warm plasma electromagnetic theory is discussed with reference to cold plasma theory for a low-β plasma, and it is shown that: (1) the lower hybrid frequency is only an approximate resonance in the warm plasma; (2) electromagnetic cutoffs occur at all harmonics of the gyrofrequency as $k \rightarrow 0$; (3) electrostatic resonances occur at all harmonics of the gyrofrequency as $k \rightarrow \infty$; (4) propagation can occur in warm plasmas at frequencies above the lower hybrid. (auth)

12921 REFLECTION OF WAVES AT AN INTERFACE IN A STREAMING PLASMA. Clemmow, P. C.; Ott, E. (Univ. of Cambridge, Eng.). J. Plasma Phys., 2: 381-93(Aug. 1968).

A uniform, unbounded, cold plasma stream, with relativistic velocity (0,U,0), traverses a vacuum half-space $y < 0$ and a dielectric half-space $y > 0$. A plane electromagnetic wave in the plasma stream in $y < 0$ is incident obliquely on the face of the dielectric. The criterion for determining which characteristic waves are present in each half space is discussed, and it is shown that, for the polarization in which B is parallel to $y = 0$, there is one reflected wave and three transmitted waves. One of the latter can be an amplifying wave. A first approximation to the transmission and reflection coefficients is found in the case when the density of the stream is low. (auth)

12922 EVOLUTIONARY CONDITIONS FOR SHOCK WAVES IN COLLISIONLESS PLASMA AND STABILITY OF THE ASSOCIATED FLOW. Morioka, Shigeki; Spreiter, John R. (Ames Research Center, Moffett Field, Calif.). J. Plasma Phys., 2: 449-63(Aug. 1968).

The evolutionary condition for transverse and normal shock waves, and the fire-hose and mirror instability conditions for the associated flow, in a collisionless, anisotropic plasma having a strong magnetic field are determined using the theoretical representation of Chew, Goldberger & Low (1956) for such a medium. The results are expressed in terms of the Mach number, Alfvén Mach number, and the ratio of the temperatures parallel and perpendicular to the magnetic field in the flow approaching the shock wave, and applied to ascertain in what range of these parameters various types of instabilities may occur. The effect of the heat flux, which does not vanish generally in a collisionless plasma, on the shock stability is discussed. (auth)

12923 ALFVEN WAVES IN RELATIVISTIC PLASMAS. Hoh, F. C. (Boeing Scientific Research Labs., Seattle). J. Plasma Phys., 2: 509-16(Dec. 1968).

Expressions for Alfvén waves, their Landau damping, and magnetosonic waves are derived in a homogeneous relativistic Vlasov plasma. Relativistic effects reduce the speed of both waves. (auth)

12924 PROPAGATION OF ELECTROMAGNETIC WAVES NORMAL TO A MAGNETIC FIELD IN A UNIFORM ANISOTROPIC MAXWELLIAN PLASMA. Stewart, P. (Univ. of Manchester, Eng.). J. Plasma Phys., 2: 591-5(Dec. 1968).

Closed forms are found for the dispersion relations describing the propagation through a uniform anisotropic plasma of the three modes of electromagnetic waves whose wave vectors are perpendicular to a steady and uniform magnetic field. Such relations are found to be conveniently expressed in terms of hypergeometric functions of the second order. (auth)

12925 A CONVERGING, CYLINDRICAL, IONIZING SHOCK. Sloan, D. M. (Univ. of Strathclyde, Glasgow). J. Plasma Phys., 2: 597-611(Dec. 1968).

The investigation deals with a collapsing, cylindrical, ionizing shock in an applied axial magnetic field. The magnetic field in the nonconducting gas ahead of the shock increases as the shock converges and the consequent increase in the Lorentz force behind the shock produces a retardation. It is shown that no accelerating self-similar solution exists and the governing equations are then solved numerically. (auth)

12926 AN EXPERIMENTAL STUDY OF TRANSVERSE IONIZING MHD SHOCK WAVES. Stebbins, Charles F.; Vlases, George C. (Univ. of Colorado, Boulder). J. Plasma Phys., 2: 633-52(Dec. 1968).

The jump conditions across a transverse ionizing MHD shock wave, where the magnetic field is in the plane of the shock, are examined. The conservation laws, in conjunction with Maxwell's laws and the equation of state, yield three jump equations in four unknowns. To uniquely describe jumps across an ionizing wave requires an additional descriptive relation. The theory of Kulikovskii & Lyubimov and, later, Chu, in which the internal structure of the shock itself supplies the missing relation, is examined. In particular, Kulikovskii & Lyubimov show, for appropriate ratios of thermal to magnetic diffusivities, that for low-speed waves the magnetic field compression across the shock is unity and the jump equations reduce to the ordinary Rankine–Hugoniot relations. For high-speed shock waves, the magnetic field compression, B_2/B_1, equals the gas compression across the wave, ρ_2/ρ_1, and the jump equations become the magnetohydrodynamic shock jump relations. Furthermore, intermediate speed shocks induce magnetic field compressions between 1 and ρ_2/ρ_1. An experiment was performed in an inverse pinch where E behind the shock, the shock and piston velocities, and the magnetic field compression across the shock, were measured over a wide range of initial conditions and shock velocities in hydrogen. The jump relations were written with B_2/B_1 as a parameter and programed into a digital computer. The program was written for real, equilibrium hydrogen. The program provided easy access to a unique solution of the jump equations for any B_2/B_1. The experiment tends to confirm the Kulikovskii–Lyubimov–Chu theory. Ordinary shock waves were observed at low speeds and near-MHD shocks were observed at high speeds. Further, the relation $E = -u \times B$, was verified for the plasma behind the shock for low-speed shock waves, and was verified to within experimental accuracy for the intermediate class of shock waves. (auth)

12927 RADIATION FROM PLASMAS. Dawson, John M. (Princeton Univ., N. J.). Advan. Plasma Phys., 1: 1-66(1968).

The generation and absorption of radiation, both longitudinal and transverse, due to particle encounters, are discussed. The scattering and coupling of the various types of waves by plasma density fluctuations are also discussed. No attempt was made to include cyclotron or synchrotron radiation. (M.O.W.)

12928 DRIFT WAVES. Krall, Nicholas A. (Univ. of Maryland, College Park). Advan. Plasma Phys., 1: 153-99(1968).

A description is given of the techniques used to derive the dispersion relation, and some techniques commonly used to examine it, in particular the local approximation, the Wentzel–Kramer–Brillouin justification of local theory, and the Nyquist diagram method. Examples are given of drift waves presently considered pertinent to the plasma stability problem. (M.O.W.)

12929 DISPERSION OF ION–ACOUSTIC WAVES. Sessler, G. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 28A: 367-8(Dec. 16, 1968).

The propagation of ion–acoustic waves at frequencies comparable to the ion plasma frequency is discussed. Experimental material is presented which demonstrates that, as expected, wave propagation does not depend on signal level in the experiments. Results obtained by Lonngren and coworkers are compared with the data of this experiment. (auth)

12930 HARMONICS OF ION OSCILLATIONS IN A NEUTRALIZED ION BEAM PLASMA. Aihara, S.; Lampis, G.; Takayama, K. (Nagoya Univ., Japan). Phys. Lett., 28A: 352-3(Dec. 16, 1968).

Harmonics of ion plasma oscillations are observed in a helium plasma produced by a back diffusion source. (auth)

12931 CHARACTER OF CYCLOTRON INSTABILITY OF HYDROMAGNETIC WAVES. Dobes, K. (Geophysical Inst., Prague). Czech. J. Phys., 18: 1133-41(1968).

The method of energy balance is used for calculating the growth rate of hydromagnetic waves ($\omega \ll \Omega_H$) in the regime of a cyclotron resonance. The HM waves are propagated at an angle to the external magnetic field. A tenuous beam of charged particles with a finite Larmor radius penetrating through a cold plasma is assumed to be responsible for the cyclotron instability process. (auth)

12932 INTERACTION BETWEEN SPACE INHOMOGENEOUS PLASMA FLUXES IN MAGNETIC FIELD. Pashitskii, E. A. (Inst. of Physics, Kiev). Zh. Tekh. Fiz., 38: 1020-6(July 1968). (In Russian).

The stability of "surface wave" oscillations is investigated in a system consisting of two bounded and contiguous plasma streams moving in opposite directions along a longitudinal magnetic field. For wavelengths $\lambda \gg a$ (a is characteristic inhomogeneity dimension), a hydrodynamic instability criterion is calculated for the tangential velocity discontinuity along an infinitely thin boundary. The results show that this surface-wave instability is possible in a short apparatus when the time of flight of the "hot" electrons is short as compared with the time of growth of the disturbances. The analysis is then extended to the case where $T_e^{(1)} \neq T_e^{(2)}$. The instability criterion for this case is given and leads to a drift instability in surface waves. It is also shown that for high plasma velocities high-frequency oscillations exist in the electron component of the plasma flow. (ATD)

12933 ABSORPTION OF THE MAGNETO-ACOUSTIC WAVES IN PLASMA. Bartov, A. V. Zh. Tekh. Fiz., 38: 1027-31(July 1968). (In Russian).

The mechanisms of energy transfer to the plasma of magneto–acoustic waves are reviewed. It is suggested that resonance absorption of magneto–acoustic waves through collisions, in plasmas previously investigated by the author, is not possible. For large-amplitude variable magnetic fields, the following condition is derived at which buildup of ion–acoustic oscillations starts to contribute to the observed absorption $\sqrt{(\pi/8)\,(m/M)}\,(\omega_{pi}/\omega)\,(u_0/u)$, ≥ 5. For small amplitude variable fields, where $n = 10^{11}$ cm^{-3}, the buildup of ion–acoustic oscillations is enhanced by energetic electrons oscillating along magnetic lines of force. This hypothesis is confirmed by the lack of high-frequency absorption observed in similar plasmas generated by contact ionization instead of high frequency discharge. (ATD)

12934 INFLUENCE OF FINITE CONDUCTIVITY OF THE MEDIUM ON THE INTERACTION OF SHOCK WAVES WITH A MAGNETIC FIELD. Volosevich, P. P.; Kurdyumov, S. P.; Popov, Yu. P. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 15-22(July-Aug. 1968). (In Russian).

The problem concerning the damping of shock waves on magnetic surfaces that was studied earlier showed that dynamics of additional processes essentially depend on the peculiarities of the law for change of conductivity of the media with temperature $\sigma(T)$ and also on the magnetic field strength H_0. A special form of the $\sigma(T)$ law is constructed here for an accurate solution of the problem. An analysis of the equations obtained shows that the dissipative properties of the media (electric conductivity and viscosity) determining the structure of the refracted wave front, have an effect on the flow characteristics as a whole. The formulated problem permits explanation of the characteristic peculiarities of destruction of dislocations in the conducting media. (tr-auth)

12935 EXPERIMENTAL STUDY OF THE INTERACTION BETWEEN WAVES AND ELECTRONS IN A PLASMA CHARACTERIZED BY A "BUMP-IN-TAIL" DISTRIBUTION FUNCTION. Frank, R. (CEN Saclay, Gif-sur-Yvette, France). Nucl. Fusion, 8: 351-6(Dec. 1968).

The measurement of the electron distribution function and its evolution was performed with an electrostatic probe. The wave–particle interaction was studied in two different cases corresponding to two regimes of the discharge. The amplitude and spectrum of the waves and their evolution were measured. (M.O.W.)

12936 SPECTRAL RESOLUTION AND SOLUTION OF FIELD PROBLEMS IN AN ANISOTROPIC AND COMPRESSIBLE MEDIUM. Chen, Hollis C. (Ohio Univ., Athens). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 741-5(Nov. 1968).

It is shown that when source currents are present in a compressible and anisotropic plasma, the longitudinal components of the electric and magnetic fields and the pressure variation satisfy a coupled inhomogeneous equation. Based on the spectral resolution of a square matrix, a general method for the solution of such an equation is presented. The solution of the coupled-wave equation is thus reduced to the evaluation of some simple integrals. Formulas for the determination of the transverse components are given. To demonstrate the simplicity of the methods, fields due to a magnetic line source are worked out in detail. Some numerical results are also included. (auth)

12937 NONLINEAR INTERACTION OF ELECTROMAGNETIC WAVES IN BOUNDED PLASMAS. Turlock, L. A. (Defence Research Board, Ottawa); James, C. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-16: 737-41(Nov. 1968).

A method is presented for the solution of second-order electromagnetic fields in a bounded plasma which is excited by two high-frequency electromagnetic waves. Due to nonlinearities inherent in any plasma, incoming waves are mixed, creating sum and difference frequencies. The signal from the difference frequency $\omega_1 - \omega_2$, where ω_1 and ω_2 are source frequencies, can be of considerable consequence when $\omega_1 - \omega_2$ is sufficiently low to cause a significant reaction in a plasma as resonant conditions develop. In particular, the problem considered is the optimization of second-order fields in a uniform plasma confined to a circular waveguide including reference to diagnostic applications. (auth)

12938 A COMPARATIVE STUDY OF SEVERAL MODELS OF THE MAGNETOPLASMA. Akkaya, Inci (Univ. of Illinois, Urbana). Radio Sci., 4: 83-90(Jan. 1969).

An unbounded, collision-free magnetoplasma of one species is analyzed by applying linearized theory. Modifications on the cold plasma dispersion surfaces due to the temperature effect are indicated by typical examples. To take into account the particle–wave interactions, a microscopic model of the magnetoplasma is analyzed for very large refractive indices and for very high temperatures. Two directions of propagation (along and across the biasing magnetic field B_0) are considered. According to the results of the microscopic model, at gyroresonance for propagation along B_0 the complex refractive index n cannot have arbitrarily large values if its phase angle is between $-\pi/4$, and $\pi/4$, whereas, for propagation across B_0, n becomes real and arbitrarily large. Both of these results contradict those of the compressible fluid model. (auth)

Shielding

Refer also to abstracts 13158, 13174, 13449, 13457, 13462, 13463, 13466, 13472, 13477, 13539, and 13553.

12939 (AERE-R-5773(Vol.1), pp 172-204) NEUTRON TRANSMISSION AND ALBEDO DATA FOR BORATED POLYETHYLENE. Futterer, Arnold T. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.).

Studies were conducted on the neutron attenuation characteristics of borated polyethylene. These studies were of monoenergetic, monodirectional plane-infinite beams of neutrons incident on laterally infinite but finitely thick slabs. The monoenergies used were: 0.1, 0.25, 0.5, 1.0, 2.0, 3.0, 5.0, and 14 MeV, at incident angles of 0, 30, 45, and 70° with respect to the slab normal, with information readout at eight thicknesses of slab for each case. Borated polyethylene moderates the neutrons and readily captures them; this reduces secondary gamma-ray and thermal-neutron background. Graphs of neutron flux versus thicknesses of slab for all eight incident energies, four incident angles, and eight thickness are used to give orders of magnitude of attenuation and to indicate the tendency toward a slowly varying relaxation length with depth in the slab. Graphs of dose transmission, and the variation of average neutron energy and average secant of the angular flux for 14-MeV neutrons are presented. Intensive tables of transport data for 14-MeV neutrons normally incident on a slab are presented as a basis for experimental verification. Tables of energy, number current, flux, and dose albedo are presented for all incident angles and energies. Finally, the method of sampling the various distributions in the Monte Carlo code are discussed along with the assumptions regarding the physics. Splitting was used as a statistics-improving device in the code. 15 references. (auth)

12940 (AERE-R-5773(Vol.1), pp 205-18) NEUTRON ATTENUATION IN SPHERICAL MATERIALS: ISOTROPIC MONOENERGETIC POINT SOURCE. Culamboug, J.; de Cosnac, B.; Devillers, C.; Lott, M.; Rastoin, J.; Sivagnanam (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

In the calculation of reactor neutron attenuation the high degree of complication makes it impossible to separate the effect of the principal parameters: geometry, numerical approximation, basic data (sources and microscopic cross sections). In order to demonstrate the effect of any one of the parameters, experiments on monoenergetic isotropic point sources such as an accelerator are useful. The geometry (which is spherical) and the method of calculation (Monte Carlo) are taken as fixed and only the basic data therein are varied according to the UNC and AWRE libraries. The Monte Carlo programs SANE and SIFER were used in Fe. Graphite was examined only with the SIFER program and the UNC data. Na was examined with the SANE program and the UNC data. Methods of calculation and the means of detection used are described. The various comparisons made enabled the groups of cross sections and the models used in the (n,n') reactions at high energy to be checked. 11 references. (auth)

12941 (AERE-R-5773(Vol.1), pp 221-40) DISCRETE ORDINATE-NUMERICAL INTEGRATION METHODS FOR BULK SHIELDING CALCULATIONS. Katoaka, Iwao; Takeuchi, Kiyoshi (Ship Research Inst., Tokyo (Japan)).

The adaptability of the discrete ordinates—numerical integration method to bulk shielding calculations is discussed from the viewpoints of the angular distribution and the spatial attenuation of radiations. These are essential in the deep penetration phenomena and/or in high source energy problems in particular. Two ways of calculating the scattering integral of the Boltzmann equation with the discrete ordinates method are examined. Three procedures for computing spatial distributions of radiations by means of numerical integration are compared for an ideal transport problem. As the result of these studies a series of procedures which adopt direct spatial integration of the transport equation are introduced. The first procedure, EOS, treats the scattering integral by the Gaussian quadrature with the help of the Legendre polynomial expansion, and the second, SELENE or MENE, uses a straightforward mechanical quadrature. Several sample calculations are illustrated by applying these procedures and the results are compared with those measured or with values from other well-established analytical methods. Affirmative answers are obtained in aspects of absolute intensity of attenuation, angular distribution, and energy spectrum. 28 references. (auth)

12942 (AERE-R-5773(Vol.1), pp 241-60) COMPARISON OF MONTE CARLO AND DISCRETE-ORDINATE CALCULATIONS WITH NEUTRON SPECTRUM MEASUREMENTS IN BULK SHIELDS. Proflo, A. E.; Antunez, H. M.; Naliboff, Y. D.; Russell, J. L. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Measurements of the fast neutron angular flux spectrum in a paraffin wax (CH_2) sphere, 76.2 cm in diameter, were made by the pulsed-source, time-of-flight method, to provide a standard for testing calculational procedures. The experiment was analyzed by the GAPLSN, GGSN, and 1DF (DTF-IV), anisotropic discrete-ordinates codes, and also the 05R Monte Carlo code. Multigroup cross sections for the discrete-ordinate codes were obtained from the GAM-II code, and in the final 05R calculations the Slaggie—Reynolds pointwise evaluated library for carbon was used. The spectrum and angular distribution of the target was measured and incorporated as the source in the calculations. Measurements were normalized to calculations at the target. Comparison of discrete-ordinates calculations with experiment established from P_3 scattering, 7 energy groups above 1 MeV, S_{16} angular mesh, and a convergence parameter of 10^{-7} was adequate to give good agreement except near 0°. The reason for the 0° discrepancy is the inability of an S_{16} mesh to represent the very forward-peaked flux. The 05R Monte Carlo calculations agreed with experiment to within the Monte Carlo statistics, when the correct source description was used and the angular bins in the 05R analysis coincided with the experimental angular resolution. 15 references. (auth)

12943 (AERE-R-5773(Vol.1), pp 261-97) DEVELOPMENT OF A MULTIGROUP SPHERICAL HARMONICS CODE AND ITS APPLICATION TO SLAB GEOMETRY SHIELDING PROBLEMS. Hehn, G.; Siegert, H. J. (Technische Hochschule, Stuttgart (West Germany). Institut fuer Kernenergetik).

A calculation method for the determination of strongly anisotropic radiation fields is reported and results of shielding problems are discussed. The method is essentially based on the P_L approximation. For representing a generalized removal concept additional higher transport corrections may be included. The multigroup spherical harmonics equations are solved numerically by means of the difference method. The equations are written as two matrix equations with the even and odd moments of the flux as unknown vectors. For each energy group the matrix equations are solved simultaneously for all mesh points, using the fact that the matrix is a tridiagonal matrix for the unknown vectors. For a problem with fixed source and only down-scattering no iteration is required. The formulas have been implemented successfully in a production program written in Algol. The approximation for the fluxes are allowed to vary from group to group. The spherical harmonics approximation of the fluxes and cross sections, the number of energy groups, the number of mesh points and the number of material regions are only restricted by the computer's core capacity. The time used for P_L solutions was less than $(L + 1)/2$ times the time used for diffusion theory calculations. The numerical procedure has proved well even at strong attenuation of the order of ten and more. A comparison with analytical results shows that the error of the numerical procedure is negligible for all attenuations occurring in reactor shields. Good agreement was found between the results of the program and Monte Carlo or S_N calculation. 11 references. (auth)

12944 (AERE-R-5773(Vol.1), pp 298-318) COMPARISON OF SPECTRA CALCULATED BY DISCRETE ORDINATE METHODS WITH TIME-OF-FLIGHT MEASUREMENTS IN POLYTHENE, GRAPHITE, AND SODIUM. Avery, A. F.; Egerton, J. (Atomic Energy Establishment, Winfrith (England)); Coates, M. S.; Gayther, D. B. (Atomic Energy Research Establishment, Harwell (England)).

Computer programs which attempt to solve the neutron transport equation rigorously require as input a detailed representation of the cross sections, the angular distributions of elastic scattering, and the energy losses in inelastic collisions. As a test of the accuracy of the basic material data, and the way in which it is treated by the NIOBE transport code, a comparison was made of the predicted neutron spectra with measurements made in polythene, graphite, and Na. The neutron source was a U target of approximately 110 cc in volume which was irradiated with a pulsed beam of 45-MeV electrons. This source was at the center of a spherical shell of the material under investigation, and the neutron spectra between 1 keV and 6 MeV and at various penetrations and angles of emergence were measured by a time-of-flight technique over a 60-meter path. The results showed that with the treatment of cross sections followed in NIOBE it is possible to predict in detail spectra over a wide energy range for these materials. 11 references. (auth)

12945 (AERE-R-5773(Vol.1), pp 319-35) NEUTRON AND GAMMA-RAY SHIELDING IN BASIC GEOMETRIES. Johnson, W. Reed; Williamson, T. G.; Coulbourn, G. I.; Risher, D. H. (Virginia Univ., Charlottesville. Dept. of Nuclear Engineering).

An experimental program is underway at the University of Virginia to measure the attenuation of neutron capture γ rays by concrete and Fe and to measure the attenuation of fission-spectrum neutrons in concrete, water and metal/water laminates. The geometry for the γ-ray measurements is the "gun barrel" geometry in which a collimated beam of γ rays impinges on slabs of shield materials and the total exposure is measured in planes parallel to and behind the shields. For comparison with calculations, this geometry is assumed to be equivalent to an infinite plane source and a point detector. The neutron experiment geometry is that of a point source in an infinite medium; measurements are made with activation detectors placed at various distances from the source. The primary source for both experiments is the University of Virginia Reactor (UVAR), a 1-MW swimming pool reactor. The experimental arrangements are described, and some earlier work and preliminary data are presented. 13 references. (auth)

12946 (AERE-R-5773(Vol.2), pp 341-69) COMPARISON OF THREE METHODS USED TO CALCULATE GAMMA-RAY TRANSPORT IN IRON. Trubey, D. K. (Oak Ridge National Lab., Tenn.).

Calculations of the γ-ray energy spectra, dose rate, and heating in a sphere of Fe were made, using the Monte Carlo and S_n methods and the data from a moments method calculation (Goldstein—Wilkins). The source was taken to be isotropic and distributed uniformly within a sphere with an energy distribution proportional to $e^{-1.1E}$, where E is the energy in MeV. The results of all calculations were in very good agreement. 27 references. (auth)

12947 (AERE-R-5773(Vol.2), pp 394-409) PLANE ISOTROPIC BUILDUP FACTORS FOR BREMSSTRAHLUNG CALCU-

LATIONS. Burrell, M. O.; Watts, J. W. Jr. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center).

Gamma-ray plane isotropic dose, energy flux, and energy current buildup factors for finite slabs are presented. Monte Carlo techniques were used to generate buildup factors for initial γ-ray energies ranging from 0.05 to 8.0 MeV with six source backings from 0 to 3.0 mfp and for five source-exit plane distances from 0.5 to 7.0 mfp. Differences of up to 50% were found in comparisons with buildup factors generated by the moments method for infinite media. 4 references. (auth)

12948 (AERE-R-5773(Vol.2), pp 449-67) CALCULATION OF GAMMA RAY BUILD-UP FACTORS IN MULTILAYER SHIELDS. Futtermenger, W.; Schubart, H.; Vogt, H.-G. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz).

Buildup factors in selected material configurations by extended numerical calculations, from which material and energy-dependent parameters are determined by comparison to the calculations, were determined for some of the most important shielding materials and for seven energies in the range from 0.5 to 10 MeV. It was found that in many cases, this method leads to good results. But there are material combinations such as very-light with very-heavy materials which permit no adequate choice of the parameters. Therefore, a modification of the formula was developed which contains an additional set of empirical parameters and allows for a good fit even to the extreme material combinations. In order to test the accuracy of the theoretical calculations an experimental method was developed, which allows the determination of buildup factors of any shield configuration within the energy range from 0.5 to 15 MeV. The results obtained for Fe and water agree with the theoretical values. 10 references. (auth)

12949 (AERE-R-5773(Vol.2), pp 468-76) EXTENSIONS AND IMPROVEMENTS OF THE BIGGI TRANSPORT PROGRAM. Penkuhn, H. (Euratom Atomic Energy Community).

Many transport codes, including BIGGI, use the same set of angular mesh points or moments for the high- and low-energy-spectra near to and far from the sources. But for deep penetration this approach can lead to troubles in precision and/or computer time consumption. How these difficulties can be overcome is discussed. For some of the improvements already included in the production code BIGGI 4T, numerical examples are given. Furthermore work was done in order to enlarge the gamma library and to prepare a similar neutron shielding code. 3 references. (auth)

12950 (AERE-R-5773(Vol.5), pp 1288-92) MOMENTS METHOD FOR HETEROGENEOUS PLANE GEOMETRY. Havranek, Miroslav (Technical Univ. of Prague (Czechoslovakia)).

The Milne problem is solved in the P_N approximation using a polynomial fits method. The plane interface is considered, which is identical with the plane isotropic source of the neutron spectrum. (auth)

12951 (GA-8741) GAMMA BUILDUP IN HETEROGENEOUS MEDIA. Engholm, B. A. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 16, 1968. Contract AT(04-3)-167. 95p. Dep. CFSTI.

Work performed in the fiscal years 1966 through 1968 on the analysis of gamma-ray buildup in heterogeneous media is described. This subtask was part of the Methods Development Task under the HTGR Base Program. The objective of this subtask was to calculate gamma buildup factors for certain materials and configurations not considered elsewhere in the literature. Data forthcoming from these calculations would aid in the design of radiation shielding for HTGR power plants. Exploratory calculations with the GGSN transport code proved disappointing. However, use of the Los Alamos DTF-IV transport code with GAMLEG cross sections produced results that were in excellent agreement with published buildup data. Comparisons were made with moments-method calculations for point isotropic sources in homogeneous media of aluminum, iron, and lead/water; agreement was within 10% for a 1-MeV source in aluminum, 17% for a 0.5-MeV source in iron, and 7% for a 2-MeV source in the lead/water medium. In addition, a check was run against experimental measurements of a Co-60 source in water; the DTF dose rate agreed with the measured dose rate within ±5%. Buildup factors for 0.5-, 1-, and 2-MeV isotropic point sources were generated for homogeneous media of ordinary concrete, iron/concrete, graphite, iron/graphite, beryllium, lithium hydride, and carbon/thorium. It is believed that the analyses of carbon, beryllium, and lithium hydride represent the first detailed calculations of gamma buildup in elements or mixtures of such low-Z numbers. Heterogeneous configurations of iron and concrete and of iron and graphite were investigated for the 0.5-MeV source energy. Empirical formulas were then fit to some of the heterogeneous data to arrive at general rules for the behavior of gamma-ray buildup in such configurations. Curves of dose buildup factor as a function of atomic number were generated, incorporating the new data for Z = 4 and Z = 6. A complete set of such curves, for source energies of 0.5, 1, 2, 3, 4, 6, 8, and 10 MeV, some involving extrapolation, are presented. (auth)

12952 (ORNL-TM-2454) APPLICATIONS OF ADJOINT FLUX CALCULATIONS TO MONTE CARLO BIASING. Schmidt, F. A. R.; Straker, E. A.; Cain, V. R. (Oak Ridge National Lab., Tenn.). Dec. 26, 1968. 28p. Dep. CFSTI.

A review of the use of the adjoint flux in the biasing of Monte Carlo calculations is presented. A detailed discussion is given of the application of discrete ordinates adjoint calculations to obtain a priori importance sampling parameters and the relative importance of energy, angle, and spatial biasing for a realistic, three-dimensional shield. More than an order of magnitude gain in efficiency over empirical biasing was obtained by the use of modified source energy selection, an energy-, angular-, and spatial-dependent exponential transform, and the application of spatial-, energy-, and angular-dependent weight standards for Russian roulette and splitting. (auth)

12953 ON EFFECTIVE ATOMIC NUMBER OF INFINITE HOMOGENEOUS MEDIA WITH γ-RAY SOURCE. Khaikovich, I. M.; Kolesov, B. M.; Bel'for, V. M.; Ovchinnikov, A. K. At. Energ. (USSR), 25: 50-2(July 1968). (In Russian).

Counting-rate parameters in infinite homogeneous mixture of various elements with a γ-radiation source, induced by uranium in equilibrium with its decay products were determined. Gamma quanta penetration through a homogeneous medium with uniformly distributed γ-radiation source was described by Boltzmann transfer equation. Mathematical data obtained were used for constructing a graph of counting rate product in a homogeneous emitting medium as a function of the atomic number Z. The results were verified by calculations of quantum and energy fluxes for uniform distribution in single element media (C, Al, Si, Ca, Fe, Mo, I, W, Pb, and U) of sources with the energy equal to 0.01% equilibrate U and with the same source in mixtures with Al base with Mo, I, W, Pb, and U with 1, 10, 30, and 50 wt % concentration. Calculations were carried out in the Minsk-2 computer using γ quanta over 20 keV. (R.V.J.)

12954 GAMMA-RAY LEAKAGE THROUGH A SLIT IN CONCRETE SHIELD. Miyasaka, Shun-ichi (Japan Atomic Energy Research Inst., Tokyo); Kanemori, Yoshihiko; Fukushima, Yutaka; Yamada, Takeshi. Nippon Genshiryoku Gakkaishi, 11: 2-8(1969). (In Japanese).

An experimental study was performed on γ-ray leakage through a slit in a concrete shield. The work was undertaken at the JRR-4 dry shielding test facility, as part of a series of mockup tests for the first nuclear ship of Japan. The paths of the slits through the shield were either straight or crooked. In the immediate vicinity of the concrete surface, the leakage γ rays through the slit was seen to contribute a significant portion of the distributed γ-dose rate, but it rapidly diminished with distance from the surface. This was due to the relatively thick shield, in reference to the slit width, adopted in the present experiments, and also because of the strong scattering characteristics of the γ rays within the slit channel. The penetration components calculated by the ray-analysis method were compared with the experimental results, and it was indicated that this method of calculation should prove useful for making rough estimations of the dose-rate distribution of leakage γ rays. (auth)

Solid-State Physics

Refer also to abstracts 11499, 11546, 11913, 12702, 13267, and 13305.

12955 (AI-AEC-12721, pp 339-55) PHYSICAL RESEARCH. Bauer, W.; Keefer, D. W.; Neely, H. H.; Sosin, A.; Thommen, K. H.; Garr, K. R.; Vawter, D. D. (Atomics International, Canoga Park, Calif.).

The effects of 1 MeV electrons on electrical resistivity in cystalline solids and semiconductors are described. 21 references are included. (D.C.C.)

12956 (CEA-CONF-1135) INTERNAL FRICTION IN IRRADIATED NICKEL. de Keating-Hart, G.; Moser, P. ([Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires]). [1968]. 2p. (CONF-680910-6). Dep.

From International Conference on Vacancies and Interstitials in Metals, Juelich, Germany.

Five internal friction peaks were found in electron- or neutron-irradiated Ni. Most are associated with magnetic after-effect or annealing stages of resistivity. The defects responsible for these peaks are discussed. (D.L.C.)

12957 (COO-1439-2) RADIATION INTERACTIONS IN SOLIDS: SURFACE AND HIGH-PRESSURE EFFECTS. Final Report. Maynard, Charles W.; Vogelsang, William F. (Wisconsin Univ., Madison). Dec. 13, 1968. Contract AT(11-1)-1439. 14p. Dep. CFSTI.

ARGON IONS—effects of 300-eV, on surface properties of germanium crystals
GERMANIUM—radiation effects on work function and catalytic activity of crystal surfaces of, 300-eV argon-ion
HIGH-PRESSURE SYSTEMS—development of cells for irradiation under pressure
NEUTRON DIFFRACTOMETERS—design of high-pressure fixed-angle
PRESSURE VESSELS—development for high-pressure neutron diffractometer (D.L.C.)

12958 (IS-T-256) THERMAL CONDUCTIVITY AND LORENZ FUNCTION OF GADOLINIUM, TERBIUM, AND HOLMIUM SINGLE CRYSTALS. Nellis, William Joel (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 90p. Dep. CFSTI.
Thesis.

The thermal conductivity of gadolinium, terbium, and holmium single crystals has been measured as a function of temperature from 5 to 300°K. The steady state heat flow method was used. For each element measurements were taken in the [11$\bar{2}$0] (a-axis) and in the [0001] (c-axis) directions of the hexagonal close-packed crystal structure. Electrical resistivity measurements were made on the same samples to obtain Lorenz functions. The a-axis conductivity of gadolinium shows a sharp change of slope at 294°K. The c-axis conductivity has a minimum at 275°K and goes smoothly through the Curie temperature, 293°K. The a-axis conductivity of terbium shows little indication of the Curie point at 221°K and manifests a change of slope at 231°K. The c-axis conductivity is essentially constant from 222°K to 230°K, the Neel point, at which temperature a change of slope occurs. In holmium the conductivities of both axes show slight decreases at 20°K, the Curie point. The a-axis conductivity has a minimum at 131°K, the Neel point. The c-axis conductivity increases below the Neel point and has a change of slope at 132°K. Anomalies near magnetic transition temperatures are interpreted in terms of magnetic superzone energy gaps and spin-disorder scattering. High-temperature anisotropy is interpreted in terms of Fermi surface anisotropy. Lorenz numbers anomalously large relative to L_0 suggest that phonons and magnons can carry heat in addition to electrons. (auth)

12959 (RD/B/N-1212) COLLISION CASCADES IN GOLD IN THE ENERGY RANGE 3 TO 169 keV. Hancock, R.; Warner, A. G.; Woolley, R. L. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov. 1968. 21p. Dep.

A comprehensive study of collision cascades of Pb ions in Au targets was made, using apparatus built to measure the energies of ions scattered from thin absorber foils into a solid angle of 2π steradians. The Pb ions were obtained by recoil from radioactive alpha disintegration and the energies of ions in the cascade were measured by a time-of-flight technique. (auth)(UK)

12960 (SC-T-69-1003) DENSITY OF STATES FOR TRANSITION METALS. II. ISOCHROMAT SPECTROSCOPY OF hcp III A- AND IV A-METALS. Merz, H.; Ulmer, K. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from excerpts of Z. Phys., 212: 435-7; 438-45; 447-8(1968). 13p. Dep. CFSTI.

An abstract of the original German article appeared previously in NSA 22: 34783. (L.M.T.)

12961 (UCRL-Trans-10312) STUDY OF THE ATTACK OF LOW-ENERGY ARGON IONS ON A SINGLE CRYSTAL OF SILVER. Haymann, P. Translated by J. D. Crofts for Univ. of California, Lawrence Radiation Lab., Livermore, from Compt. Rend., 251: 85-7(July 4, 1960). 6p. Dep. CFSTI.

When the relative orientation of a crystal and a beam of argon ions (accelerated under 8 kV) is varied, modifications of selective attack are observed. The conditions necessary for a crystal plane to be revealed by ionic attack are deduced. (auth)

12962 (UCRL-Trans-10313) DECORATION FIGURES DUE TO OXIDE PRECIPITATES OBTAINED BY IONIC BOMBARDMENT. Haymann, P.; Lecomte, C. Translated by B. Haro for Univ. of California, Lawrence Radiation Lab., Livermore, from Compt. Rend., 250: 530-2(Jan. 18, 1960). 8p. Dep. CFSTI.

The bombardment of uranium specimens placed in an enclosure under a low partial pressure of oxygen (10^{-5}mm) by low-energy argon ions gives rise to an increase in oxide content that appears selectively at the sites of crystal lattice defects. Certain conditions for this phenomenon are indicated. (auth)

12963 (UCRL-Trans-10314) ACTION OF ARGON ION BEAMS ON METAL SURFACES. Haymann, Pierre. Translated by Z. F. St-Gallay for Univ. of California, Lawrence Radiation Lab., Livermore, from J. Chim. Phys., 57: 572-80(1960). 25p. Dep. CFSTI.

A study was made of nucleon-lattice interactions at 100 to 20,000 eV in ion bombardment. The properties of the ion source are considered, and the importance of the sputtering yield is pointed out. The disordering effect of ion bombardment on the target lattice and the parameters (voltage, ion density, incidence angle, surface state, orientation, oxygen) of the ionic attack are discussed. Theories proposed for ion bombardment are assessed, and it is concluded that deep layers must be involved. (D.L.C.)

12964 H AND F BANDS IN ALKALINE-EARTH FLUORIDES. Tanton, G. A. (Redstone Arsenal, Ala.); Shatas, R. A.; Williams, J. E.; Mukerji, Ambuj. J. Chem. Phys., 49: 5532-6(Dec. 15, 1968).

Spectral positions of the F-band peaks induced in CaF_2, SrF_2, and BaF_2 by irradiating at liquid He temperatures with 50-kV x rays were determined to be at 377, 442, and 611 nm, respectively, and fit an Ivey–Mollwo relation having an exponent of 4. The absorption spectrum of each of the three alkaline-earth fluorides consists of the F band and a band at a shorter wavelength. Both appear to be composite bands. A simultaneous decrease of both bands was obtained by dark bleaching and also by illuminating with F-band light. It is suggested that the bands at shorter wavelength are analogous to the near-uv bands seen in x-irradiated alkali metal halides. Spectral positions of the peaks assigned primarily to H centers are at 314, 325, and 364 nm in CaF_2, SrF_2, and BaF_2, respectively, and fit an Ivey–Mollwo relation with the exponent 1.5. (auth)

12965 CORIOLIS COUPLING IN ^{153}Eu INVESTIGATED BY THE MOESSBAUER EFFECT FOLLOWING COULOMB EXCITATION. Shnidman, Robert. Baltimore, Johns Hopkins Univ., 1968. 104p.
Thesis.

Using Coulomb excitation to populate the 83.37-keV state (the second member of the ground state band) of ^{153}Eu, a Moessbauer effect has been observed for the first time. Isomer shifts were measured with a Eu_2O_3 target and several divalent absorbers. The various absorbers consisted of 180 mg/cm^2 EuB_6, 325 mg/cm^2 EuB_6, and 315 mg/cm^2 $EuSO_4$. The absorbers contained natural isotopic abundance. Temperatures of 10 and 26°K were employed for both the target and absorbers. The average value of the isomer shift appropriate for EuB_6 vs Eu_2O_3 was $(+0.36 \pm 0.06)$ mm/sec, which corresponds to an energy shift of $(+1.00 \pm 0.17) \times 10^{-7}$ eV. Using previously determined estimates $\Delta|\psi_s(0)|^2 = (-1.7 \pm 0.5) \times 10^{26}$ cm^{-3}, it is deduced that $\delta\langle r^2\rangle = (-3.1 \pm 1.1) \times 10^{-3}$fm^2 for the 83-keV state. The narrowest linewidth was (6.4 ± 0.4) mm/sec, and this was observed with the 180 mg/cm^2 EuB_6 absorber at 26°K. Purity of the divalent charged state of the absorbers was determined by performing Moessbauer experiments with the 103-keV state whose spectra displays large isomer shifts. The measured isomer shifts of this last state are consistent with previous determinations. Calculations are presented to show that the mixing of the 103-keV state band into the ground-state band via Coriolis forces will produce a slightly greater decrease in mean square charge radii of the 83-keV state than observed. If the isomer shift of this mechanism is subtracted from the observed value, $\delta\langle r^2\rangle/\langle r^2\rangle = (1.2 \pm 0.5) \times 10^{-4}$ is obtained as the contribution due to nonadiabatic effects such as centrifugal stretching. This value is the same order of magnitude as recently calculated for even–even nuclei with deformations similar to ^{153}Eu. (Diss. Abstr.)

12966 MAGNETIC PROPERTIES OF BINARY ALLOYS AND INTERMETALLIC COMPOUNDS CONTAINING VANADIUM. Creveling, Louis Jr. San Diego, Calif., Univ. of California, 1968. 122p.
Thesis.

Results of magnetic measurements on binary alloys and intermetallic compounds containing vanadium (and gold, mainly) are presented. The intermetallic compound Au_4V, formed through an order–disorder transformation at 560°C, becomes ferromagnetic at 60°K. Above that temperature the susceptibility satisfies a Curie–Weiss law. The induced moment at absolute zero, the effective moment, the transition temperature, and the temperature-independent component of the susceptibility all vary from sample to sample but typical values are 0.5 μ_B/V ion, 1.7, 50°K, and 150×10^{-6} emu/(gm-at.wt.) respectively. The variation is thought to be due to extreme magnetic hardness coupled with a high degree of crystal imperfection. These and other results indicate that a model of localization in the molecular field approximation is adequate to describe the ferromagnetism. In agreement with earlier work, dilute solid solutions of vanadium in gold have temperature-dependent susceptibilities. These are describable by a Curie–Weiss law, with parameters that vary with concentration and heat treatment. Temperature-dependence occurs only in the concentration range ≈0.1 to 30 at.% V; the Curie constant reaches a maximum value at 5 to 10 at.% V. A model is presented which can account for the results given by assuming that a vanadium ion only localizes in gold provided that there are no vanadium neighbors within a critical distance. The susceptibility of Al_3V satisfies a Curie–Weiss law with a critical temperature of ≈–65°K and an effective moment per vanadium ion of ≈0.32 μ_B. No magnetic ordering appears to take place. These results are compared with Au–V alloys and Au_4V. In conclusion, results on other vanadium alloys and compounds are given and the implications for the possible existence of other ferromagnetic intermetallic compounds are discussed. (Diss. Abstr.)

12967 MAGNETIC STRUCTURES IN $UP_{0.95}S_{0.05}$. Lander, G. H.; Kuznietz, Moshe; Baskin, Y. (Argonne National Lab., Ill.). Solid State Commun., 6: 877-9(Dec. 1968).

Neutron-diffraction studies showed that, between 122 and 35°K, $UP_{.95}S_{.05}$ (with NaCl-type structure) has the same antiferromagnetic order and ordered moment as UP. Below ~27°K, however, $UP_{0.95}S_{0.05}$ has a different antiferromagnetic structure that has neither been reported, nor predicted by molecular field theory for face-centered-cubic structures. (auth)(UK)

12968 CHANGE OF DRIFT MOBILITY IN AMORPHOUS LAYERS OF ARSENIC SELENIDE UNDER IRRADIATION. Kruglov, V. I.; Strakhov, L. P. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 289-90(1968). (In Russian).

The drift mobility in irradiated thin layers of glassy As_2Se_3 of 10- to 20-micron thickness was determined and correlated with the applied voltage and photoconductivity. Light impulses of 0.7-msec half width were filtered through the glass filters or through a filter comprising a similar layer of As_2Se_3, using a semi-transparent Pt electrode and a sprayed-on As_2Se_3 film applied on the cold support under 10^{-6} torr vacuum. The signal at field polarity corresponding to hole drift was 10^2 times higher than the signal corresponding to electron drift, indicating the hole characteristics of conductivity. The time of signal increase corresponding to the time of electron drift depended linearly on the applied voltage and was defined by $\mu d_e = (0.8-1) \times 10^{-6}$ cm^2/V sec. Hole drift was characterized by rapid increase of the signal at low potentials and at sufficiently high voltages a rapid and a slow section of increase appeared. The drift mobility of holes was calculated as $\mu d_h = \mu_0\theta = 2$ to 5×10^{-4} cm^2/V sec, μ_0 being the microscopic mobility, and θ a constant defining adhesion. Under irradiation with low-absorbing light obtained by filtration through an As_2Se_3 layer, drift mobility of electrons and holes increased nearly linearly with photoconductivity. Under irradiation with strongly absorbed light, the distribution of carriers has little effect and the slow increase of the signal starts during a considerable period after the action of the light impulse. (ATD)

12969 SURFACE-INDUCED NUCLEAR SPIN RELAXATION IN GASEOUS ^{3}He AND DIFFUSION STUDIES OF He(2^3S_1) IN GASEOUS HELIUM: THE INTERACTION POTENTIAL AT LONG RANGE. Fitzsimmons, William Allen. Houston, Tex., Rice Univ., 1968. 101p.

Thesis.

Experiments on ^{3}He nuclear spin relaxation at pyrex and quartz surfaces have revealed that two surface relaxation mechanisms are operative. These results are interpreted in terms of a phenomenological theory incorporating distinctly different relaxation processes at low and high temperatures, respectively. The low-temperature mechanism involves ^{3}He adsorption on the glass surface, while the high temperature mechanism involves permeation of ^{3}He into the container material. The latter mechanism can be eliminated by using relatively impermeable aluminosilicate glass containers, and the resulting ^{3}He nuclear spin relaxation times become impressively long (>2 × 10^5 seconds) at moderate temperatures. Implications of these results in the area of nuclear gyroscopes and of high-density polarized ^{3}He targets for nuclear scattering experiments are discussed. The existence of a repulsive barrier at intermediate nuclear separations between a He(2^3S_1) metastable atom and a He(1^1S_0) ground state atom has been well established both experimentally and theoretically. This investigation deals with the nature of the repulsive interaction for large internuclear separations. The diffusion coefficient, and thus the diffusion cross section, for He(2^3S_1) atoms in helium gas was measured by a pulsed afterglow technique over the temperature range of 1 to 300°K. In order to compare with experiment, the diffusion cross sections are calculated by a quantum-mechanical partial-wave analysis based on assumed long-range potentials. The long-range repulsive interaction is represented by a parametric expression that exhibits the qualitative features of the previous theoretical calculations. It is shown that the previous theoretical calculations substantially over estimate the repulsive interaction energy at large nuclear separations. Subsequently, the parameters are varied in a manner consistent with the theoretical predictions until the calculated diffusion cross-sections agree with experiment. The interaction potential determined on the basis of the diffusion data is used to calculate total and excitation-transfer cross-sections and the results are in excellent agreement with previous and independent experimental measurements. (Disser. Abstr.)

12970 IMPURITY EFFECTS ON THE IONIZATION STATES OF F-AGGREGATE COLOR CENTERS IN SODIUM FLUORIDE. Chandra, Ashoka. Ithaca, N. Y., Cornell Univ., 1968. 214p.

Thesis.

In order to study the role of hydroxide and peroxide impurities on color-center properties in sodium fluoride, several crystals were grown with the Kyropoulous technique. In addition to undoped samples, several crystals doped with varying amounts of sodium hydroxide and sodium peroxide were grown. The optical state of hydroxide and oxygen impurities in the doped samples was studied. The study of OH^- ion in the samples has been reported previously. The oxygen impurities in peroxide-doped samples are considered in the present work. The optical absorption in peroxide-doped samples consists primarily of three bands at 275, 235, and 195 mμ, respectively. On the basis of photochemical evidence these bands have been assigned to O^-, O^0, and O^{2-}, respectively. Upon irradiation of the samples with x rays at room temperature, significant differences are observed. The production of F centers is determined almost entirely by impurities with a small contribution due to intrinsic processes. The large coloration in hydroxide- and peroxide-doped samples are explained on the basis of photochemical reactions involving impurities which act as sources of anion vacancies and electrons. Although the overall M-center concentration in doped samples is larger than in undoped samples, the M-center formation in relation to F centers is suppressed in doped samples. Important differences are observed in hydroxide- and peroxide-doped samples in relation to the charge state of the aggregate centers. Electron-deficient centers are stabilized and the probability of their formation is enhanced in hydroxide doped samples. In peroxide-doped samples, the excess electron centers are favored. These and similar other observations are explained on the basis of model photochemical reactions, which generate "electron traps" in hydroxide-doped samples and excess electron concentration in peroxide-doped samples. Several new absorption bands have been observed in hydroxide- and peroxide-doped samples. A band at 312 mμ is found to grow in both hydroxide- and peroxide-doped samples. On the basis of photochemical, ESR, and luminescence data, the band was assigned to a defect consisting of an electron trapped at "anion-vacancy and substitutional O_2^0" complex. In hydroxide-doped samples, a band at 725 mμ was observed. This band is identified as arising from the F_2^+ (ionized M center) center in NaF. The previously inferred but unobserved broad absorption band of the F_3^+ center is found at 519 mμ. By comparison of the intensity and half width of the broad band with those of the zero phonon line, the Huang Rhys factor for the F_3^+ center is determined to have a value of 6. The M′ center in NaF is identified by means of its zero-phonon line at 12920 A°. Two bands observed at 575 mμ and 622 mμ are identified with N_1 and N_2 centers (in NaF), respectively. By means of polarized bleaching experiments, bands associated with higher transitions of the M center were observed. The bands at 347 mμ and ~290 mμ are identified as M_2 and M_3 bands in NaF. Several other previously unreported bands and sharp phonon lines were also observed. A complete listing of the observed bands and sharp lines is presented. Ivey plots for F, M_1, R_1, R_2, N_1, N_2, F_2^+, M′, F_3^+, and R′ centers which include the results for NaF reported here are also given at appropriate places. (auth) (Disser. Abstr.)

12971 ELECTRON IRRADIATION AND ISOCHRONAL ANNEALING OF SINGLE CRYSTALS OF ALUMINUM AT LOW TEMPERATURES. Longshore, Randolph Earl. Clemson, S. C., Clemson Univ., 1968. 99p.

Thesis.

Electron irradiation is a means of producing point defects in metal samples. The influence of crystal structure on the production of damage was studied using single crystal samples of aluminum. Aluminum foil (with a thickness of 2.54×10^{-2} cm and a purity of 99.999%) was used to grow large grains by a strain-induced grain boundary migration technique. The grains were x-rayed to determine crystallographic orientation and large grains with the desired orientation were thinned and cut into individual samples with an acid saw. Samples were mounted on a holder and an additional chemical polishing reduced the thickness to approximately 3 × 10^{-3} cm. Single-crystal samples and polycrystalline samples were kept below 10°K during the irradiations with energetic electrons. Irradiations were performed at electron energies from 0.18 to 0.40 MeV. After each irradiation, isochronal annealing was performed to resolve the I_B, I_C, and I_{D+E} substages. Damage rate values of these aluminum samples were similar to published results. A minimum threshold energy value of 15 ± 0.8 eV was determined for the samples. Annealing data showed that the I_B substage was influenced by the irradiation energy and the orientation of the irradiation direction with respect to the crystallographic directions in a sample. The percent of I_B recovery for the single crystal sample that was irradiated in the ⟨100⟩ direction increased rapidly as the irradiation energy was decreased. Recovery for the I_B substage of the single crystal that was irradiated along the ⟨110⟩ direction decreased as the irradiation energy was decreased. It was therefore reasonable to conclude that the I_B substage resulted from defects that were created by atomic displacements along the ⟨100⟩ direction. Theoretical calculations were made to indicate the dependence of the I_B recovery upon irradiation energy and irradiation direction. These calculations were performed by assuming that, for stage I, defects could be formed in the ⟨100⟩ and ⟨110⟩ directions with the I_B substage associated with the ⟨100⟩ direction and with the I_C and I_{D+E} substages associated with the ⟨110⟩ direction. Energy degradation and multiple scattering of the bombarding electrons were considered in the computations. Reasonable agreement was obtained between these theoretical values and the experimental results of the I_B substage for the single crystal samples. (TSS) (Disser. Abstr.)

12972 THE MAGNETIC PROPERTIES OF SINGLE CRYSTALS OF ERBIUM AND SOME YTTRIUM–ERBIUM AND LUTETIUM–ERBIUM ALLOYS BETWEEN 1.2 AND 300°K. Gray, Walter James. Iowa City, Iowa, Iowa State Univ., 1968. 132p. Thesis.

Carefully analyzed spherical single crystal samples were prepared of erbium and of alloys whose approximate compositions were: $Y_{25}Er_{75}$, $Y_{50}Er_{50}$, $Y_{75}Er_{25}$, $Lu_{25}Er_{75}$, $Lu_{50}Er_{50}$, and $Lu_{75}Er_{25}$. Magnetic measurements were made on each of these samples along the three principle crystallographic axes in the range 1.2 to 300°K and applied fields up to 27.9 K-Oe. For pure erbium, the saturation moment along the c-axis was found to be 276.0 ± 2.0 emu/g. by fitting the data to a T^2 plot and extrapolating to 0°K. This is to be compared with a theoretical value of 300.5 emu/g. None of the alloys studied were ferromagnetic in zero field. The Néel temperatures of the alloys were proportional to the ⅔ power of the average de Gennes factor, $T_N = AG^{2/3}$. The constant, A, was found to be 49.0 for the yttrium–erbium alloys and 53.5 for the lutetium–erbium alloys. An anomalous peak was observed in the c-axis moment vs. temperature curves for two alloys, $Lu_{25}Er_{75}$ and $Y_{50}Er_{50}$. In both alloys, the peak was not observed at fields less than about 5 K-Oe. This peak corresponds to the ferromagnetic–antiferromagnetic transition in pure erbium. The small basal-plane anisotropy observed in the alloys at low temperatures (b-axis moment larger) was found to decrease with increasing temperature and with decreasing erbium concentration. From the paramagnetic data, the magnetic moments, in terms of the effective number of Bohr magnetons per erbium ion, were found to be within experimental error of 9.97 ± 0.1 for erbium as well as for all the alloys. (auth) (Disser. Abstr.)

12973 ANOMALIES IN THE ELASTIC PROPERTIES OF V AND Ta: THE ROLE OF INTERSTITIAL IMPURITIES. Smith, R. E.; Bolef, D. I. (Washington Univ., St. Louis). Phys. Rev. Lett., 22: 183-5(Feb. 3, 1969).

Anomalies in the elastic constants and thermal expansion of vanadium single crystals in the range 180 to 260°K are reported and discussed in terms of a model of precipitation of hydrogen impurities. An extension of the impurity precipitation model is used to explain the appearance of sharp anomalies in the temperature dependence of the nuclear-acoustic-resonance linewidth in tantalum single crystals. (auth)

12974 DEPENDENCE OF NUCLEAR POLARIZED ^{57}Fe MOESSBAUER SPECTRA ON THE MAGNITUDE AND SIGN OF THE HYPERFINE FIELD. Reivari, P. (Technical Univ. of Helsinki, Otaniemi, Finland). Phys. Rev. Lett., 22: 167-9 (Feb. 3, 1969).

The Moessbauer spectra of ^{57}Fe, with the ^{57}Co source in iron and palladium matrices, respectively, were measured in a ^{3}He/^{4}He dilution refrigerator. Both the magnitude and sign of the effective field at ^{57}Co can be determined from nuclear polarization effects in the spectra, without recourse to an external magnetic field. Experimental data are also presented on the Kapitza thermal boundary resistance which, together with radioactive self-heating, prevents the source from cooling below 0.15°K. (auth)

12975 LATTICE-DIRECTED TRAJECTORIES OF NEGATIVELY CHARGED PARTICLES. Nip, H. C. H.; Hollis, M. J.; Kelly, J. C. (Univ. of New South Wales, Kensington). Phys. Lett., 28A: 324-5(Dec. 16, 1968).

In previous channelling and blocking work, positive projectile particles have been considered. Preliminary calculations indicate that negative particles may weave along atom rows in stable trajectories which oscillate from one side of the row to the other. (auth)

12976 NEW SATELLITE STRUCTURE OF Nd^{3+} IONS IN RARE-EARTH TRICHLORIDES. Prinz, G. A.; Cohen, E. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-1447. Phys. Rev., 165: 335-44(Jan. 10, 1968). (NYO-1447-32).

High-resolution, low-temperature absorption spectra of Nd^{3+} in various rare-earth trichlorides have been obtained in the region 4000 to 9000 Å. Detailed Zeeman studies were made in fields up to 36 kOe. The study concerns the properties of the sharp satellites separated from the electronic transitions by energies of 0.1 to 20 cm^{-1}. The dependence of these satellites upon host lattice and controlled impurities was investigated. The detailed structure of the satellites indicates near-neighbor interactions between the rare-earth ions. It is probable that the satellites are due to Nd^{3+} ions in distorted sites near crystal imperfections, in particular, dislocations. (auth)

12977 NEUTRON DIFFRACTION ON PIEZOELECTRIC VIBRATING RESONATORS. Petrzilka, V. (Charles Univ., Prague). Czech. J. Phys., 18: 1111-16(1968).

A proposal was made to use neutron diffraction to investigate the dynamics of lattice vibrations of piezoelectric resonators. The results obtained explain some experimental facts published earlier. The obtained spectral distribution of diffracted neutrons is analogous to the spectral distributions of acoustically modulated γ rays in the Moessbauer effect. (auth)

12978 INVESTIGATION OF THE STRUCTURE OF PARAMAGNETIC CENTRES IN MONOCRYSTALS OF γ-IRRADIATED L-CYSTINE DIHYDROCHLORIDE ON EXPOSURE TO LIGHT. Krivenko, V. G.; Kayushin, L. P.; Pulatova, M. K. (Inst. of Biological Physics, Moscow). Biophysics (USSR) (Engl. Transl.) 13: 35-45(1968).

Translated from Biofizika, 13: 33-41(1968).

The nature of paramagnetic centers in γ-irradiated crystalline L-cystine dihydrochloride was studied and their sensitivity to the action of light was determined. The appearance of a paramagnetic center $[R\text{-}S\text{-}S\text{-}R]^-$ was confirmed. It was assumed that during γ irradiation at a temperature of 77°K negative $R-S^--S-R$ and positive $R-S^+-S-R$ ion radicals were formed. The latter is unstable and breaks down into the non-radical form and the R–S. radical. $R-S^+-S-R \rightarrow RS^+$: +RS. Thus, after irradiation each elementary cell contained the negative ion radical $R-S^--S-R$ and radical and nonradical forms: RS· and RS^+: i.e., the α_1 radical and any of the β_1 radicals the (β_1' or β_1'' radical is equiprobable) and therefore, the number of α_1 radicals must be twice as great as the β_1' or β_1'' radicals while the number of β_1 paramagnetic centers which pass on heating into the β_2-paramagnetic centers on turning of the SCH_2 group through thermal motion into a new stable position must be equal to the concentration of the latter. The α_1 paramagnetic center absorbed light in the region 360 < λ <600 mμ; the β_1 radicals were not sensitive to the action of light. It has been established that at room temperature the RS· free radical of γ-irradiated L-cystine dihydrochloride is stable. The orientation of the paramagnetic centers formed under the action of γ rays in the elementary cell of the monocrystal has been determined. (auth)

12979 ENHANCED STRAIN AMPLITUDE DEPENDENCE OF INTERNAL FRICTION IN THE MIXED STATE OF NIOBIUM. Kramer, Edward J.; Bauer, Charles L. (Carnegie-Mellon Univ., Pittsburgh). Appl. Phys. Lett., 13: 362-4(Nov. 15, 1968).

Strain-amplitude dependence of internal friction was measured as a function of the magnetic state in a niobium single crystal. An enhanced dependence is observed in the mixed state, which is attributed to compression and subsequent breakaway of fluxoids from moving dislocations. (auth)

12980 FISSION-FRAGMENT DAMAGE IN IRIDIUM. Greenwood, J. H.; Morgan, D. V. (Cavendish Lab., Cambridge, Eng.). J. Appl. Phys., 40: 417-18(Jan. 1969).

In the course of other investigations of Ir, a short examination was made of fission-fragment damage, using the conventional methods of transmission electron microscopy. It is suggested that the damage is probably comparable to that in Pt and Au. (M.H.R.)

12981 THE P–T PHASE DIAGRAM OF InSb AT HIGH TEMPERATURES AND PRESSURES. Banus, Mario D.; Lavine, Mary C. (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 40: 409-13(Jan. 1969).

The pressure–temperature phase diagram of InSb is refined to show the boundaries between the high-pressure tetragonal (InSb II) and orthorhombic (InSb IV) phases and extended to about 125 kbar to locate the boundary of the new phase (InSb III). The existence of these structures as stable phases in their phase fields is demonstrated by high-pressure, high-temperature x-ray studies and by x-ray studies and superconductivity measurements on these phases retained by quenching to 77°K. The structures of InSb II and InSb IV are confirmed, and a hexagonal structure for InSb III is proposed. The hexagonal cell has the dimensions (at ~90 kbar) of a = 6.10 Å and c = 5.71 Å with a calculated density of 8.5 g/cc. Values are reported for the compressibility of phases InSb I, InSb III, and InSb IV and for the thermal expansion coefficients, under pressure, of phases InSb I and InSb IV. (auth)

12982 DISLOCATION CHANNELING IN NEUTRON-IRRADIATED NIOBIUM. Tucker, R. P.; Wechsler, M. S.; Ohr, S. M. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 400-8 (Jan. 1969).

Dislocation channels cleared of radiation-produced defect clusters were observed by transmission electron microscopy in polycrystalline niobium irradiated to 4×10^{18} neutrons/cm^2 ($E > 1$ MeV) and then deformed in tension to 6.6% strain. From electron-diffraction patterns and diffraction contrast ($g \cdot b$) analysis, the $\{110\}$ plane was determined to be the plane on which the dislocation channels formed in most cases. The strain due to the motion of slip dislocations in the channels was deduced from the offset at intersections between the channels and other microstructural features. The strain corresponded to the passage of 1 to 3 slip dislocations per slip plane. Several mechanisms for the clearing of defect clusters by slip dislocations are discussed. These include: annealing due to the heat of plastic deformation, chopping up or sweeping up of defect clusters by slip dislocations, and annihilation by antidefects. (auth)

12983 ELECTRON IRRADIATION OF SINGLE CRYSTALS OF ALUMINUM. Longshore, R. E.; Chaplin, R. L. (Clemson Univ., S. C.). J. Appl. Phys., 40: 351-4(Jan. 1969).

Details are given about the preparation of suitable aluminum samples for studying the effects of electron irradiation of single crystals. The observed annealing spectra of stage I differ for samples irradiated along different crystallographic directions. Results show that when the atomic-recoil energy is slightly greater than the threshold energy, the I_B substage is enhanced for irradiations parallel to the $\langle 100 \rangle$ but is suppressed for the $\langle 110 \rangle$. Evidently, the most favorable conditions for producing I_B-type defects occur when the initial atomic displacements cause atoms to move in the $\langle 100 \rangle$. A qualitative discussion is given which explains the observed energy dependence of the single-crystal samples in terms of atomic displacements along $\langle 100 \rangle$ and $\langle 110 \rangle$ directions. (auth)

12984 SINGLE-CRYSTALLINE ELASTIC CONSTANTS OF ZrCo$_2$ AND HfCo$_2$ IN THE TEMPERATURE RANGE 4.2° TO 300°K. Shannette, G. W.; Smith, J. F. (Ames Lab., Iowa). J. Appl. Phys., 40: 79-82(Jan. 1969).

The elastic constants of single crystals of the cubic Laves phases ZrCo$_2$ and HfCo$_2$ were determined by the pulse-echo technique over the temperature range 4.2° to 300°K. Debye temperatures for the two materials were computed from extrapolations of the elastic constants to 0°K. The ratio of these Debye temperatures is such as to indicate that the primary difference between the two materials is a difference in vibrational amplitudes resulting from the mass difference between zirconium and hafnium. Further substantiation of a close similarity of interatomic force interactions in the two materials is obtained by comparison of appropriate combinations of lattice parameters and force constants. (auth)

12985 STRONG SOLID STATE EFFECT IN AN INHOMOGENEOUS ELECTRON SPIN SYSTEM. DYNAMIC POLARIZATION OF FLUORINE NUCLEI IN IRRADIATED LiF. Zegers, P.; Van Steenwinkel, R. (CCR–EURATOM, Ispra, Italy). Physica, 33: 332-42(1967).

The dynamic polarization of fluorine nuclei in LiF, containing paramagnetic V_K centers, was measured at 80°K. The enhancement of the nuclear polarization ($E = 100$) obtained was higher than one would expect for the case of an inhomogeneously broadened ESR line, consisting of spin packets, which are much narrower than the ESR line. The experimental results could be explained by the assumption that the magnetic field at the position of the paramagnetic centers is fluctuating in time because of the relaxation flipping of the surrounding nuclei. It is shown that when these fluctuations are sufficiently rapid, the maximum enhancement γ_e/γ_n can be obtained even in the case of an inhomogeneous line with thermally isolated spin packets. The maximum enhancement is then independent of the packet width. (auth)

12986 ORIENTATIONAL DEPENDENCE OF FAST PROTONS ENERGY LOSSES IN KBr SINGLE CRYSTAL. Shipatov, E. T.; Kononov, B. A.; Ivakin, V. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 136-8(1968). (In Russian).

The energy distribution of protons passing through 41.2-mg/cm^2-thick KBr monocrystal was measured at 0°, 0.6°, 1.2°, and 6° angles. The crystal axis $\langle 100 \rangle$ was studied using 6.72-MeV protons with beam diameter of 2 mm and angular divergence of ±0.2°. The mean proton energy losses at 6° was of the order of ~1420 ± 60 keV, which is in agreement with published theoretical values. (R.V.J.)

12987 THE MAGNETIC SUSCEPTIBILITIES OF SOME RARE EARTH SILICIDES AND GERMANIDES WITH THE D8$_8$ STRUCTURE. Narasimhan, K. S. V. L.; Steinfink, H.; Ganapathy, E. V. (Univ. of Texas, Austin). J. Appl. Phys., 40: 51-4(Jan. 1969).

The magnetic susceptibilities for neodymium, gadolinium, and dysprosium germanides and silicides were measured between about 60° to about 700°K. Plots of $1/\chi$ vs T show a Curie–Weiss behavior, but deviations from it are observed below room temperature. The deviations become smaller with decreasing temperature and in most instances tend to approach the asymptote just above the transition temperature. These compounds have the D8$_8$ structure and a ferromagnetic spin ordering for rare earth atoms in the crystallographic 6(g) sites, and an antiferromagnetic ordering in the 4(d) sites is consistent with the observed behavior. (auth)

12988 ORIENTATION DEPENDENCE OF VIBRATIONAL MODES AND THEIR ASSOCIATED DISLOCATION DAMPING IN HEXAGONAL METALS. Henneke II, Edmund George. Baltimore, Johns Hopkins Univ., 1968. 183p.

Thesis.

Elastic vibrations in solid materials are known to decay with time. In recent years, it has been suggested that the motion of dislocations in metals can play an important role in the removal of energy from the elastic vibrations and hence can account for a portion of their damping. Since the damping in metals is relatively small, it has only a second-order effect on elastic wave propagation. That is, the metal can be assumed to be purely elastic. With this assumption, the modes of elastic wave propagation for plane waves were calculated for various orientations at one-degree intervals in the hexagonal metals magnesium, titanium, beryllium, cadmium, and zinc. The phase velocities and corresponding particle vibration directions have been determined for each of the three elastic modes which can propagate in a given crystallographic direction. The results of these calculations are given in graphical form. In addition, the deviation of the direction of maximum energy flow from the direction of wave propagation is given as a function of crystallographic orientation. The phenomenon of internal acoustical conical refraction is discussed in conjunction with its applicability to hexagonal metals. It is shown that this phenomenon can occur only in certain particular metals of this crystal class, depending on the values of the elastic constants. Furthermore, in these particular metals, the "cone" degenerates into a plane. The orientation factors for dislocation damping of both traveling waves and standing waves are calculated and given in a graphical form. In one case it has been assumed that dislocations are generated and moving in one slip system only and related orientation factor for each elastic mode has been determined accordingly. In a second case, dislocations are assumed to be generated and moving in all three slip systems which normally occur in the hexagonal metals at room temperature. For this case, an average or total orientation factor has been determined. (Disser. Abstr.)

12989 FERRO- AND ANTIFERROMAGNETISM OF SOLID SOLUTIONS OF US–ThS AND UP–ThP. Chechernikov, V. I.; Shavishvili, T. M.; Pletyushkin, V. A. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., 23: 115-17(July-Aug. 1968). (In Russian).

The magnetic properties of US–ThS and UP–ThP systems with 100 to 5 mole % US in the US–ThS system and 100 to 2 mole % of UP in the UP–ThP system were studied in the temperature range from 77 to 900°K at various magnetic field intensities. Measurements, in a 10^{-4} mm Hg vacuum, showed that the US–ThS system with up to 60% ThS was a ferromagnetic material and the UP–ThP system with up to 50% ThP was antiferromagnetic. The magnetic properties of both systems are determined mainly by the US and UP compounds, respectively. Studies of UP$_2$–ThP$_2$ and U$_3$P$_4$–Th$_3$P$_4$ showed that the magnetic properties of these systems change monotonously with the dilution of the system. (R.V.J.)

12990 FORMATION OF PRECIPITATE PHASES IN ALUMINIUM BY ION IMPLANTATION. Thackery, P. A.; Nelson, R. S.

(United Kingdom Atomic Energy Authority, Harwell, Eng.). Phil. Mag., 19: 169-81(Jan. 1969).

The formation of precipitates of second phases during ion implantation of thin metallic films is discussed in general terms. Observations from an electron microscope investigation of precipitation behavior during the implantation of aluminum specimens with 70- to 80-keV Cu^+, Sb^+, and Pb^+ ions are described in detail. Special reference is made to the effects of radiation-enhanced diffusion and surface sputtering on precipitate growth and distribution, and to the morphology and orientation relationships of the precipitates concerned, which include $CuAl_2$, AlSb, and Pb in both solid and liquid states. (auth) (UK)

12991 PROBLEMS IN SOLID-STATE PHYSICS. Goldsmid, H. J. (ed.). London, Pion Ltd., 1968. 472p. 84s.

Sections by various authors are included on the following topics: Crystallography and crystal structure; growth of crystals; chemical bonds and lattice energy; elasticity of crystals; thermal properties of the crystal lattice; defects in crystals; dielectricity; magnetism and paramagnetism; ferromagnetism; antiferromagnetism and ferrimagnetism; magnetic resonance; electron theory of metals; energy band structures; properties of homogeneous semiconductors; semiconductor junctions; optical properties of solids; superconductivity. (UK)

12992 INTERACTION OF Li AND O WITH RADIATION-PRODUCED DEFECTS IN Si. Young, R. C.; Westhead, J. W.; Corelli, J. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 40: 271-8(Jan. 1969).

The interaction of Li atoms with O impurities and with defects produced in Si by 1.5- and 47-MeV electrons was studied using infrared spectroscopy. Lithium was diffused in low oxygen-containing uncompensated Si with initial resistivity in the range 15 to 28,500 $\Omega \cdot cm$ and in high oxygen-containing Si with initial resistivity of 15 to 200 $\Omega \cdot cm$. The Li concentration in the samples varied from about 10^{16} to $\lesssim 10^{19}$ Li atoms/cm^3. New radiation-induced bands at 1.4 and 1.7 μ are observed. Divacancy production as measured by the 1.8- and 3.3-μ defect bands is markedly decreased in samples of high Li content with concomitant growth of the Li-associated 1.4- and 1.7-μ bands. Annealing of the 1.4- and 1.7-μ bands strongly depends upon Li concentration. Recovery occurs at a temperature of 150°C for the 1.4-μ band, and at 350°C for the 1.7-μ band, for samples containing $\sim 6 \times 10^{17}$ Li/cm^3. In samples containing $\sim 2 \times 10^{16}$ Li/cm^3, the bands at 1.4- and 1.7-μ disappear after annealing at 330° and 470°C, respectively. Sharp Li- and O-associated defect bands in the 700 to 1000 cm^{-1} range are produced only in high-O-containing samples, and the presence of Li has a pronounced effect on the production and recovery of the A-center defect (830 cm^{-1} band). In samples of high Li content the predominant absorption is due to free carriers and is found to be in agreement with predictions of theory. A search for defect absorption bands attributable to vibrational modes of the isolated interstitial Li^+ ions yielded negative results. (auth)

Theoretical Physics

Refer also to abstracts 12670, 12845, and 13305.

12993 (ORNL-4297) GROUND-STATE ENERGY EIGENVALUES AND EIGENFUNCTIONS FOR AN ELECTRON IN AN ELECTRIC-DIPOLE FIELD. Turner, J. E.; Anderson, V. E.; Fox, Kenneth (Oak Ridge National Lab., Tenn.). Dec. 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Ground-state energy eigenvalues and eigenfunctions are obtained by a variational method for an electron in the field of a finite, stationary, permanent electric dipole. The dipole moments studied cover the range from the minimum value required for binding ($D_{min} = 0.6393ea_0$) to $D = 400ea_0$, where the system is equivalent to the hydrogen atom perturbed slightly by a distant stationary negative charge. The eigenvalues obtained agree with those reported by Wallis, Herman, and Milnes, who determined them by another method in the range $D = 0.84ea_0$ to $30ea_0$. The normalized eigenfunctions display the manner in which the electronic charge density changes from that of the hydrogen atom at very large D to a flat distribution characteristic of a zero-energy continuum state as the minimum moment is approached from above. Optimized variational wave functions for different values of D are presented for use in other calculations. Contour maps and profiles of electronic charge density are shown for a number of values of D. Mean values of the powers −1, 1, and 2 of the distances of the electron from the dipole charges are also calculated. (auth)

12994 UNIFICATION OF PHYSICAL THEORIES. Mercier, Andre (Bern Univ.). pp 15-23 of Symposia on Theoretical Physics and Mathematics. Vol. 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968.

From Symposia on Theoretical Physics and Mathematics, Madras. See CONF-670123.

The development of physics and the possibility of unifying the physical theories are briefly discussed. (L.B.S.)

12995 SYMPOSIA ON THEORETICAL PHYSICS AND MATHEMATICS. VOLUME 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968. 211p. (CONF-670123).

Sixteen papers are presented; separate abstracts are presented for six. Other papers deal with representations of Dirac groups; kinetic theory of gases and statistical mechanics; functional differential equations; convex functions and related inequalities; harmonic differential forms in a general manifold; theory of univalent functions; analytic continuation; congruent embedding in Boolean vector spaces; Raikov systems; and the design of programmed-motion systems. (L.B.S)

For abstracts of individual papers see: 12476, 12994, 12996, 13143, 13196, and 13320.

12996 RELATIVISTIC WAVE EQUATIONS FOR HIGHER SPIN AND THEIR QUANTIZATION. Mathews, P. M. (Univ. of Madras). pp 33-45 of Symposia on Theoretical Physics and Mathematics. Vol. 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968.

From Symposia on Theoretical Physics and Mathematics, Madras. See CONF-670123.

Certain recent results are presented on relativistic wave equations which describe particles of definite (but arbitrary) spin s and mass m. The quantization of these equations is discussed. To be more specific, the equations to be considered will have the Schroedinger form $i\, \partial\psi/\partial t\, (x,t) = H\psi(x,t)$ with the Hamiltonian H chosen in such a way as to leave it invariant under the transformations of the Poincaré group as well as under the discrete transformations: P (space inversion), T (time reversal), and C (charge conjugation). (M.O.W.)

12997 SOME PROPERTIES OF RADIATION. Kothari, D. S. (Univ. Grants Commission, New Delhi). Proc. Nat. Inst. Sci. India, Part A, 34: 75-85(Mar. 1968).

The development of quantum mechanics and the concept of the superposition of states is briefly outlined. Other topics mentioned include interference of photons (coherence effects), nondegenerate radiation, and effect of radiation on Lamb shift. (W.D.M.)

12998 OPERATORS FOR TIME OF MOTION AND DELAY TIME INDUCED BY SCATTERING. Glen, T. T. (Memorial Univ. of Newfoundland, St. John's). Can. J. Phys., 47: 279-89 (Feb. 1, 1969).

Recently, Lippmann showed that a time operator might exist in quantum theory and that its explicit form is $i\partial/\partial E$ in the energy representation. In this paper, it is stressed that $i\partial/\partial E$ actually represents only the time which the particle used to move from the scattering center to a certain point at the outside. (Later on, this time is called the "time of motion.") It is also shown that, although it is possible to define an operator for the "time of motion" of the particle in the energy representation, it is necessary to introduce a new conjugate representation of the energy representation, the "time representation," to overcome difficulties which may arise in the evaluation of the mean time of motion $\langle T \rangle$. If the position representation is used for the calculation instead, the difficulties are met. The reason is that time of motion T, position x, and energy E are not two-by-two compatible variables. Bearing in mind that $i\partial/\partial E$ only represents the time of motion of the particle, the explicit form of the decay time operator Q can then be deduced in terms of the scattering matrix S directly from the time of motion operator by simple reasoning. This form is $Q = -i(\partial S/\partial E) \cdot S$, as was found previously. Some interesting features of the delay time operator are sketched at the end of the paper. (auth)(Canada)

12999 UPPER AND LOWER BOUNDS TO QUANTUM-MECHANICAL SUM RULES. Weinhold, F. (Mathematical Inst., Oxford). J. Phys., A (London), 1: 655-61(Nov. 1968).

It is pointed out that when a set of sum rules S(k) are composed into an array S with elements $S_{ij} = S(i + j)$, the resulting matrix S has no negative eigenvalues. This property often permits rigorous upper and/or lower bounds to the true value of a particular sum rule to be assigned when values of other sum rules are known. In certain cases the bounds are identical with those obtained by Gordon (1968) using a generalized theory of Gaussian integration. The technique is illustrated by an application to oscillator strength sum rules in the ground state of the hydrogen atom and the negative hydrogen ion, and it is shown how any available information about individual oscillator strengths can be applied to further improve the bounds. (auth)(UK)

13000 ON GYRORESONANCE. Laird, M. J. (King's Coll., London). J. Plasma Phys., 2: 59-64(Feb. 1968).

The motion of a charged particle in the field of a plane circularly polarized wave propagating along a uniform magnetic field B_0 is investigated. For the wave magnetic field small compared with B_0, the equations of motion simplify to those of the pendulum, and a simple picture of what happens for particles near gyroresonance results. Expressions are found for the amplitude and period of the pitch-angle oscillations. Departures from uniformity and possible applications to the magnetosphere are briefly discussed. (auth)

13001 RASCHET ELEKTROMAGNITNYKH POLEI NA VYCHISLITEL'NYKH MASHINAKH. (Calculation of Electromagnetic Fields by Computers). Tozoni, O. V. Kiev, Izdatel'stvo Tekhnika, 1967. 252p.

New methods for computer calculations of steady and quasi-steady electromagnetic fields and for calculations in partially homogeneous fields and fields in nonlinear media are described. These methods can be used for calculating magnetic systems for various types of electromagnetic installations. The algorithms based on the new method can be applied for automatic computation of two-dimensional fields of any geometry. Examples of programming dc magnetic systems and multiphase screened current systems are included. (R.V.J.)

13002 NEW DERIVATION OF THE INTEGRO-DIFFERENTIAL EQUATIONS FOR CHANDRASEKHAR'S X AND Y FUNCTIONS. Bellman, R. (Univ. of Southern California, Los Angeles); Kagiwada, H.; Kalaba, R.; Ueno, S. J. Math. Phys. (N.Y.), 9: 906-8 (June 1968).

The X and Y functions of radiative transfer satisfy a system of integro–differential equations which form the basis of an effective numerical treatment. These integro–differential equations are derived from the integral equation for the source function and the differential equation for the resolvent. (auth)

13003 DIFFUSE TRANSMISSION OF LIGHT FROM A CENTRAL SOURCE THROUGH AN INHOMOGENEOUS SPHERICAL SHELL WITH ISOTROPIC SCATTERING. Bellman, R. E. (Rand Corp., Santa Monica, Calif.); Kagiwada, H. H.; Kalaba, R. E.; Ueno, S. J. Math. Phys. (N.Y.), 9: 909-12(June 1968).

A partial-differential–integral equation is derived for the angular distribution of the radiation which is diffusely transmitted through an inhomogeneous, isotropically scattering, spherical shell when there is a constant net flux of radiation normally incident on the inner surface. An equation is also derived for the strength of the diffusely reflected radiation when the shell is illuminated at each point on the outer surface by constant isotropic incident radiation. The equations obtained appear to lend themselves well to numerical solution. Astrophysically, the situation corresponds to determining the brightness of a spherical planetary nebula. As far as is known, the equations are new and exact. (auth)

13004 POSSIBLE INTERPRETATION OF QUANTUM MECHANICS. de la Pena-Auerbach, L. (Univ. Mexico, Mexico City); Garcia-Colin, Leopoldo S. J. Math. Phys. (N.Y.), 9: 916-21(June 1968).

It is shown that to Schrödinger's equation, one may associate a Markoff process in the Smoluchowski approximation with an external force acting on the system which is a measure of its interaction with the vacuum. This interaction is, in this scheme, responsible for the stochastic character of the motion. The physical interpretation of the usual momentum and energy operators emerges in a natural way from the theory. Thus, one is immediately led to Heisenberg's uncertainty relations. However, this interpretation of quantum mechanics is valid only within the limits of validity of Smoluchowski's equation. As a simple example, the one-dimensional harmonic oscillator is treated. (auth)

13005 SIMPLE GENERALIZATION OF SCHROEDINGER'S EQUATION. de la Pena-Auerbach, L. (Univ. Mexico, Mexico City); Garcia-Colin, Leopoldo S. J. Math. Phys. (N.Y.), 9: 922-7(June 1968).

A possible generalization of quantum mechanics is examined by showing that the motion in phase space of a classical Brownian particle may be described by a complex probability amplitude depending on the phase-space coordinates and the time, and obeying a Schrödinger-like equation. However formal this result may seem, the usual dynamical operators may be defined whose physical meaning stems directly from the theory. An outstanding feature of the formalism is that ordinary quantum mechanics in configuration space may be recovered in a limiting process whereby the velocity variable, defined now through a statistical distribution, is eliminated. Therefore, it plays the role of a hidden variable. This result supports recent reinterpretations of von Neumann's theorem on the nonexistence of such variables in quantum mechanics and serves as a counterexample of the usual interpretation of his theorem. (auth)

13006 EFFECTIVE LONG RANGE ORDER AND PHASE TRANSITIONS IN FINITE, MACROSCOPIC ONE AND TWO DIMENSIONAL SYSTEMS. Imry, Y. (Israel Atomic Energy Commission, Yavne. Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3326. Ann. Phys. (N. Y.), 51: 1-27(Jan. 1969).

The concept of long-range order is discussed for finite macroscopic systems. It is shown that if the interaction range of strength, in units of kT, is of O(log N), long-range order is obtained in one-dimensional systems. Short- and long-range interactions are able to combine to cause long-range order even when each of the two interactions by itself is much too weak to do so. A physical picture of the effects of the long-range interactions is presented and supported by detailed calculations. It is also shown that the theorem stating that the two-dimensional Heisenberg model does not exhibit long-range order is inapplicable when the interaction strength in units kT is of O(log N), or when the range of the interaction is of $O(\log N)^{1/2}$. The two-dimensional Bose gas will condense at temperatures of $O(T_0/\log N)$, where T_0 is the condensation temperature in three dimensions. The recent proof that superfluid long-range order is impossible in two dimensions, is shown to be based, for finite N, on an analogous fact in the free gas, which is invalid according to the above. Consideration of thin Bose films shows that the transition from three-dimensional (condensation at T_0) to two-dimensional (condensation below T_0) behavior occurs at film thickness of order log N. This result can be of practical importance. (auth)

13007 EXPLICIT SOLUTION OF THE CONTINUOUS BAKER–CAMPBELL–HAUSDORFF PROBLEM AND A NEW EXPRESSION FOR THE PHASE OPERATOR. Bialynicki-Birula, I.; Mielnik, B.; Plebanski, J. (Univ., Warsaw). Ann. Phys. (N. Y.), 51: 187-200(Jan. 1969).

An explicit formula for an arbitrary function of the evolution operator is derived. With its use, the continuous analog of the Baker–Campbell–Hausdorff problem is solved. The application of this result to the quantum theory of scattering leads to a new closed expression for the phase shifts in every order of perturbation theory. (auth)

13008 RADIATIVE TRANSFER IN A GAS EXCITED BY X-RAYS. Tarter, Curtis Bruce. Ithaca, N. Y., Cornell Univ., 1967. 311p.

Thesis.

The physical properties of a gas of constant density surrounding a point source emitting bremsstrahlung radiation are determined for several combinations of parameters characterizing the gas and source. The elements are assumed to have their average cosmic abundances, and the density is taken low enough so that all ions are effective in their ground states. The atomic physics of such a gas are discussed in some detail, and expressions are given which enable the heating and cooling rates, ionization equilibrium, and electron temperature and density, to be calculated for any specified radiation field. Formulae for computing both the continuous and line spectra of the gas are also given. Notable features are the utilization of photoionization cross sections which take account of screening, accurate Gaunt factors, updated values of collision strengths, and exact expressions for forbidden line intensities. The theory of radiative transfer is used to develop approximate procedures for determining the radiation field in a spherically symmetric system in which continuous absorption, electron scattering, and diffuse ionizing radiation may all be important. The intensity of radiation from the source is obtained from an expression which reduces to the exact result in the absence of scattering, and to the diffusion limit in the case when scattering is very important. In treating the diffuse radiation the main approximations are that the photons can be treated as if they were emitted isotropically outward, and that the neglect of scattering for these photons will not lead to serious error. Some physical and mathematical justifications are given for both of these approximations. Within the theoretical framework described above numerical techniques are developed to calculate the temperature, ionization equilibrium, and radiation field in the gas as a function of distance from the source. Of particular interest is the method used to obtain the angular distribution of the diffuse ionizing radiation. Essentially, the interval 0 to $\pi/2$ is broken down into five angular bands, and as they move outward, photons are geometrically transferred from band to band until they are absorbed. These numerical techniques are employed to construct a number of models for sources emitting bremsstrahlung radiation at characteristic energies ranging from those of very soft to very hard x rays. Graphs and tables of electron temperatures, ionization equilibria, and emission spectra, are given as a function of position for a series of optically thick models, in which scattering, absorption, and diffuse emission, play a major role in determining the state of the gas. Five of these models are constructed for luminosities typical of those usually assumed for the quasi-stellar sources if they are at cosmological distances, and two are done using lower values of luminosity and/or density. In addition, the temperature and ionization equilibrium are given for two optically thin models, in which the physical state of the gas at any point depends only on the ratio of luminosity to density. In such circumstances radii scale with the square root of this ratio, so that the results are applicable to a wide range of situations. The general properties of the medium surrounding the source are then discussed analytically and qualitatively, using the numerical models as representative examples. Individual topics include the functional dependence of various quantities on luminosity, density, and central temperature, the ionization structure of hydrogen and helium, and the effects of modifying the geometry and relaxing the constant density assumption. The accuracy of the numerical work is also examined. The results are also briefly applied to existing observational information on the discrete x-ray sources and the quasi-stellar sources. (Diss. Abstr.)

13009 SECOND APPROXIMATION OF THE GENERALIZED WKB METHOD. I. Zhirnov, N. I. (Moscow State Teachers Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 3, 58-66(1968). (In Russian).

A solution was obtained for a one-dimensional Schroedinger equation corresponding to the second approximation of the generalized WKB method (Petrashen–Miller–Good method). Energy quantization conditions were found for the bound state of particles in potential wells. (tr-auth).

13010 APPROXIMATE ANALYTIC SOLUTION OF THE EQUATIONS IN QUANTUM-MECHANICAL PROBLEMS. Amirkhanov, I. V.; Guryanov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 28A: 346-7(Dec. 16, 1968).

The Schrödinger equation has an analytic solution for a small number of simple potentials. In the general case the equation must be solved numerically. Approximate solutions of the Schrödinger equation with arbitrary local (or nonlocal) potential, are obtained in analytic form. The same method can be applied to a wide class of integro–differential equations and of systems of such equations. (auth)

13011 GEOMETRICAL MODEL FOR TRILINEAR SCATTERING PROCESSES. Bonifacio, R.; Masserini, G. L. (Univ., Milan). Phys. Lett., 28A: 359-60(Dec. 16, 1968).

A quantum-mechanical model for stimulated scattering processes, which takes into account the depletion of the pump field, is developed. It is shown that the dynamics of these processes is given by a Bloch model. (auth)

13012 DRIFTS AND HYDRODYNAMICS OF PARTICLES IN A FIELD WITH A HIGH-FREQUENCY COMPONENT. Klima, R. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 1280-91(1968).

The equation of smoothed motion of a particle in a general weakly inhomogeneous electromagnetic field with a high-frequency component is derived. The frequency of the hf field is assumed to differ from the single-particle gyroresonances. A simple generalization of the drift theory given by the presence of an hf field is indicated. The corresponding hydrodynamic description is derived including the effect of collisions. (auth)

13013 RADIATION OF CHARGE MOVING IN THE FIELD OF THE PLANAR WAVE IN MAGNETIC FIELD. Bagrov, V. G.; Khalilov, V. R. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 37-41(1968). (In Russian).

Classical electrodynamic methods were used in studies of emission problem of electrons moving in a plane monochromatic circular polarized wave field and in a homogeneous magnetic field parallel to the wave propagation. Equations were obtained for the total radiation intensity and for the angular distribution. Special problems were analyzed for the cases in which the photon is emitted in the direction of the incident wave ($\Theta = 0$) and in the opposite direction ($\Theta = \pi$). (R.V.J.)

13014 MOVEMENT AND RADIATION OF AN ELECTRON POSSESSING VACUUM MOMENT IN THE FIELD OF PLANAR ELECTROMAGNETIC WAVE. Ternov, I. M.; Bagrov, V. G.; Klimenko, Yu. I. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 50-7(1968). (In Russian).

Studies were made of an electron with anomalous magnetic moment moving in the field of a plane circular-polarized electromagnetic wave. The generalized Dirac equation obtained was used for resolving the problem of the electron electromagnetic radiation (the Compton effect). The results showed that the anomalous magnetic moment in an electron results in the shift of frequencies, alterations in the total energy, radiation polarization and spinor effect. (tr-auth)

13015 NEGATIVE ABSORPTION OF SYNCHROTRON RADIATION. Il'in, V. S.; Kostyunina, G. P. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 144-5(1968). (In Russian).

The magnitude and sign of the total energy of induced absorption and emission in a magnetic field was studied as a function of the spectral composition and external electromagnetic polarization, and also, as to type of the function of the electron distribution by pulses. The emission was calculated for N_0 electrons with identical pulses acted upon by electromagnetic waves with wave vector $k = \{0, k \sin \theta, k \cos \theta\}$, polarization λ, and intensity I_k; the pulse is directed perpendicular to magnetic field H; θ is the angle between the H and k direction. (R.V.J.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

13016 (ORNL-TM-2151) UPPER LIMIT FOR THE ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Dress, William (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 151p. Dep. CFSTI.

Thesis. Submitted to Harvard Univ., [Cambridge,] Mass.

The method of obtaining a beam of very cold neutrons using a bent neutron-conducting tube is discussed and the design, construction, and operation of the neutron magnetic-resonance spectrometer are presented. An upper limit of $|\mu_e/e| < 3 \times 10^{-22}$ cm. on the neutron's electric dipole moment was set. This is consistent with the assumptions of parity conservation and time-reversal invariance. An examination of the data for systematic errors is also provided. (C.E.S.)

13017 (SLAC-Trans-88) STUDY OF THE FORMATION OF (e^+e^-) PAIRS BY 1.25-4 GeV ELECTRONS. Bem, Ya.; Grishin, V. G.; Muminov, M. M.; Strel'tsov, V. N. Translated for Stanford Linear Accelerator Center, Calif., from report JINR-P1-4023. 19p. Dep. CFSTI.

A method for studying the formation of electron-positron pairs by electrons using a propane bubble chamber in a magnetic field of 14.3 kG is described. Cross sections for direct formation of electron–positron pairs in $e^- + Z \rightarrow e^- + e^+ + e^- + Z$ reactions at 1.25 to 4 GeV are presented. (W.H.K.)

13018 INVESTIGATION OF THE REACTION $\pi^-p \rightarrow \pi^-p\gamma$ AT 340 MeV. Blokhintseva, T. D.; Kravtsov, A. V.; Sherman, S. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 926-32(Nov. 1968). (In Russian).

The reaction $\pi^-p \rightarrow \pi^-p\gamma$ was studied using a hydrogen bubble chamber and a π^- meson beam with the energy 340 MeV. 148 events of the reaction with $k_\gamma > 40$ MeV/c were identified that corresponds to the cross section $(0.16 \pm 0.02) \cdot 10^{-27}$ cm^2. The contribution of a diagram with the vertex corresponding to the process $\gamma\pi \rightarrow \pi\pi$ was discriminated from the hard part of the γ-quanta momentum spectrum. The constant of this process was found to be $C^2 = 1.0 \pm 0.2$. Angular spectrum of γ-quanta in cms is given. (auth)

13019 WIDE-ANGLE ELECTRON–PROTON BREMSSTRAHLUNG. Bernardini, C. (CNEN, Frascati, Italy); Felicetti, F.; Querzoli, R.; Silvestrini, V.; Vignola, G.; Meneghetti, L.; Vitale, S.; Penso, G. Nuovo Cim., Lett., 1: 15-20(Jan. 1, 1969).

The differential cross section for wide-angle electron-proton bremsstrahlung $e + p \rightarrow e + p + \gamma$ was measured using the external beam of the Frascati 1 GeV electron synchrotron. The results were compared with the theoretical cross section, calculated by quantum electrodynamics to lowest order in e^2, including proton form factor; corrections due to the virtual Compton contribution are also included. No significant deviation was found between the measured and the expected cross section in the spacelike and timelike lepton propagator region. (L.B.S.)

13020 EXPERIMENTAL INFORMATION ON THE $\pi^\pm$ PHOTOPRODUCTION AMPLITUDES. Diebold, R. (Stanford Univ., Calif.). Phys. Rev. Lett., 22: 204-7(Feb. 3, 1969).

Recent data on $\pi^\pm$ photoproduction at 3.4 GeV are used to investigate the nature of the amplitudes contributing to these processes. It is found that a large amplitude corresponding to natural-parity $G = +1$ exchange is necessary to explain the data, even in the region $t \approx -0.6$ GeV^2 where Reggeized ρ exchange must vanish. This implies a large contribution from some ρ' trajectory or form cuts, absorption, etc. The large $G = +1$ exchange amplitude needed to explain the π^-/π^+ ratio is only marginally consistent with the vector-dominance model. (auth)

13021 MEASUREMENT OF THE SPECTRUM AND ASYMMETRY OF LOW MOMENTUM POSITRONS FROM μ^+ DECAY. Derenzo, S. E.; Hildebrand, R. H.; Vossler, C. (Univ. of Chicago). Phys. Lett., 28B: 401-3(Jan. 6, 1969).

A hydrogen bubble chamber measurement of $\mu^+ \rightarrow e^+$ decays below 7 MeV indicates asymmetry as in a V–A theory and gives the value -0.13 ± 0.20 ($\rho \equiv {}^3/_4$) for the parameter η. This value is used to derive new limits for the coupling constants. (auth)

13022 NEUTRAL-PION PHOTOPRODUCTION IN THE BACKWARD DIRECTION. Rutherfoord, John Penn Jr. Ithaca, N. Y., Cornell Univ., 1968. 76p.

Thesis.

The differential cross section for photoproduction of the neutral pion off of protons at a pion center-of-mass production angle of 180° has been determined for a range of incident photon laboratory energies from 650 MeV to 1750 MeV. The incident photon beam was a bremsstrahlung beam obtained from the Cornell 2 GeV electron synchrotron by allowing the internal electrons to strike a tungsten rod. The beam then intercepted a liquid hydrogen target and after emerging was monitored by a Wilson quantameter. Only the recoil proton was detected. It entered a magnetic spectrometer of 1.5% resolution and fired a scintillation counter telescope. The proton's time-of-flight was measured from the first to the last counter. It was kinematically impossible for our apparatus to separate out protons from Compton scattering but it is believed that this cross section is very small. Some protons from pion pair production were also detected but their contribution was found to be small by taking excitation curves at two of our data points. In order to convert the counting rates into values of the cross section, it was necessary to determine the spatial and energy distribution of the incident photon beam. Information from detailed studies of the bremsstrahlung beam was used to calculate the acceptance of the spectrometer and to correct the quantameter reading because some of the photon beam striking the hydrogen target was stopped by the lead solid angle defining aperture. The results show a great deal of structure. The first peak in the data is centered at the second pion-nucleon resonance, the $D_{13}(1525)$ and is 1.85 ± 0.05 μ barns. The next peak is less pronounced and shifted up slightly in energy from the $F_{15}(1688)$ resonance. It is 1.10 ± 0.03 μ barns. The third peak occurs 100 MeV below the $F_{37}(1924)$ resonance and is 1.31 ± 0.3 μ barns. The data drop sharply above this. The statistical errors on all points are less than 5% so there is little uncertainty in the structure but there is an uncertainty in the normalization which is a slowly varying function of the energy going from 4% at 1750 MeV to 15% at 650 MeV. (Disser. Abstr.)

13023 COHERENT PHOTOPRODUCTION OF LOW-MASS PION PAIRS. Eisenhandler, Eric Fred. Ithaca, N. Y., Cornell Univ., 1968. 93p.

Thesis.

The production of $\pi^+\pi^-$ pairs by photons of energy 1 GeV to 2 GeV has been measured for dipion masses between 300 MeV and 500 MeV. The two pions were detected in a pair spectrometer using a single bending magnet at 0° to the beam. Mass spectra for 0° dipion production from hydrogen and carbon show no structure near 400 MeV (σ-meson). Measurements were made for 0°-production from H, Be, C, Al, Cu, Sn, Ta, and Pb, and for 2°- and 4°-production from C, Cu, and Pb. The dependence on Ar of the 0° cross section implies coherent production. A sharp forward peak is indicated by the angular distributions, as well as by the proportionately large hydrogen forward cross section compared to published hydrogen total cross sections. The data can be understood quantitatively using a model closely related to the Drell process, in which the virtual pion is diffraction scattered. The agreement is improved in the hydrogen case by inclusion of an interference term between this model and diffraction photoproduction of the ρ-meson. (Disser. Abstr.)

13024 PHOTOPRODUCTION OF NEGATIVE PIONS ON NEUTRONS AT PHOTON ENERGIES BETWEEN 0.2 AND 2.0 GeV. Hilpert, H. G. (Technische Hochschule, Aachen); Lauscher, P.; Matziolis, M.; (and others). Nucl. Phys., B8: 535-44(1968).

Total and differential cross sections of the reaction $\gamma + n \rightarrow p + \pi^-$ have been determined for photon-energies between 0.2 and 2.0 GeV. Below 500 MeV the differential cross sections are compared with theoretical predictions derived from fixed-momentum-transfer dispersion relations. (auth)

Weak

Refer also to abstract 11904.

13025 MEASUREMENT OF A AND B COEFFICIENTS IN THE DECAY OF POLARIZED NEUTRONS. Christensen, C. J.; Krohn, V. E.; Ringo, G. R. (Argonne National Lab., Ill.). Phys. Lett., 28B: 411-12(Jan. 6, 1969).

The coefficients found were $A = -0.115 \pm 0.008$ and $B = 1.01 \pm 0.04$. The value of A leads to $|G_A/G_V| = 1.26 \pm 0.02$ for the ratio of coupling constants in beta decay, and B is consistent with $G_S = G_T = 0$. (auth)

13026 MUON CAPTURE IN LEAD. Sashin, Donald. Pittsburgh, Carnegie-Mellon Univ., 1968. 101p.

Thesis.

The disappearance rate, decay rate, and decay electron energy spectrum were measured for negative muons stopping in a thin lead sheet sandwiched between two optical spark chambers. A carbon reference target was used to eliminate the necessity of knowing the precise value of the detection efficiency of the apparatus, and the muon concentration of the beam of particles from the cyclotron. The decay electron energy spectrum was also found for muons stopping in the carbon target. Scanning the muon and electron tracks in the spark chambers enabled the elimination of most of the background of muons stopping in material other than the target. The decay electron energy was measured in a large sodium iodide crystal. The decay and disappearance rates for negative muons in lead were found to be 0.46 ± 0.03 (10^6/sec) and 13.1 ± 0.9 (10^6/sec) respectively. A theoretical spectrum previously calculated by Huff and corrected for experimental resolution was compared to the measured decay electron energy spectrum for negative muons in lead. A best value for $\rho = 0.72 \pm 0.05$ was obtained with a χ^2 of 23.8 compared to an expected χ^2 of 19 ± 6.2. In a similar way the data for negative muons stopping in carbon were analyzed to give a best value of $\rho = 0.72 \pm 0.06$ with a χ^2 of 15.6 compared to an expected χ^2 of 19 ± 6.2. (Disser. Abstr.)

Strong (Baryon-Induced)

Refer also to abstract 13198.

13027 (ANL-HEP-6812, pp 108-46) MULTIPARTICLE FINAL STATES IN ANTIPROTON REACTIONS IN FLIGHT. Cooper, W. A. (Argonne National Lab., Ill.).

A review is given on bubble chamber studies of antiproton reactions with hydrogen and deuterium. Multiplicity, angular correlations, and cross sections for pionic and kaonic annihilations are discussed. The data are also reviewed on single and double pion production and two- and three-body hyperon production in nonannihilation interactions. (L.B.S.)

13028 (ANL-HEP-6812,pp 147-97) $N\bar{N}$ ELASTIC AND CHARGE EXCHANGE SCATTERING. Musgrave, B. (Argonne Lab., Ill.).

A review is given of presently available experimental data on $N\bar{N}$ elastic and charge exchange scattering. The low energy region with anti-nucleon kinetic energies below 300 MeV is first considered. The experiments illustrating the following features of $\bar{p}p$ elastic scattering are then discussed; a pronounced forward peak, a minimum in the direct channel, and a sharp backward peak. The data on $\bar{p}p$ charge exchange scattering above 1 GeV/c are reviewed. (L.B.S.)

13029 INTERACTION OF 21-GeV PROTONS WITH HEAVY NUCLEI OF EMULSION EXPOSED IN STRONG MAGNETIC FIELD. Azimov, S. A.; Gulyamov, U. G.; Myalkovskaya, N. M.; Svechnikova, L. N.; Chernova, L. P.; Chernov, G. M. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 8: 933-9(Nov. 1968). (In Russian).

The angular and momenta distributions are analyzed as well as the energy distribution between secondary shower particles produced from collision of 20.8 GeV/c protons with heavy ($n_h > 7$) nuclei of photoemulsion exposed in the 180 kOe magnetic field. The identity of kinematic parameters of π^+ and π^- mesons, and the presence of definite correlations between the transversal momenta and the momenta and the emission angles of shower particles are shown, the dependence of parameters of shower particles on the number of strongly ionizing particles is investigated. Experimental data at the energies 14, 21, and 24 GeV are compared with the model of intranuclear cascade. (auth)

13030 THE REACTION $pp \to N^* p\pi^-$ AT 6 GeV/c. Lyons, L. (Nuclear Physics Lab., Oxford). Nucl. Phys., B8: 686-94(1968).

Some aspects of the reaction $pp \to N^*(1238)p\pi^-$ at 6 GeV/c are compared with the predictions of a one-pion-exchange process in which some of the effects of absorption have been taken into account. The agreement between theory and experiment is encouraging. (auth)

Strong (Meson-Induced)

13031 (COO-1764-21) π^-p CHARGE EXCHANGE AT HIGH MOMENTUM TRANSFERS. Chase, R. C.; Coleman, E.; Courant, H. W. J.; Marquit, E.; Petraske, E.; Romer, H.; Ruddick, K. (Minnesota Univ., Minneapolis. School of Physics). Aug. 1968. Contract AT(11-1)-1764. 11p. Dep. CFSTI.

A spark chamber system for differential cross section measurements of $\pi^- + p \to n + \gamma + \gamma$ and $\pi^- + p \to n + \pi^+ + \pi^-$ interactions at 2 to 6 GeV/c is described. Differential cross sections for backward $\pi^- + p \to n + \pi^0$ interactions at 3, 4, and 5 GeV/c are presented. (W.H.K.)

13032 PION SCATTERING ON ALIGNED DEUTERON AND THE DEUTERON STRUCTURE. Tseren, Ch. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 909-13(Nov. 1968). (In Russian).

Dependence of the πd-interaction total cross section on the deuteron alignment is calculated in the Glauber approximation. It is shown that the cross section is very sensitive to the behavior of the deuteron wave function at small distances. (auth)

13033 EVIDENCE FOR A NEW Ξ RESONANCE AT 2500 MeV IN 10 GeV/c K^-p INTERACTIONS. Bartsch, J. (Technische Hochschule, Aachen); Deutschmann, M.; Hermanns, M.; (and others). Phys. Lett., 28B: 439-42(Jan. 6, 1969).

Baryon states with strangeness S = −2 have been studied in 10 GeV/c K^-p interactions. The existence of the $\Xi(2050)$ resonance is confirmed and also its decay into $(\Lambda\bar{K}\pi)$ is observed. Evidence is presented for a new Ξ state of mass 2500 MeV decaying into $(\Lambda\bar{K}\pi)$, $(\Sigma\bar{K}\pi)$, $(\Xi\pi\pi)$ and possibly into $(Y\bar{K})$. The possibility of there being a Ξ resonance near 2240 MeV is discussed. (auth)

13034 EVIDENCE FOR THE EXISTENCE OF TWO $Y_1{}^*(1660)$ RESONANCES. Eberhard, Philippe; Friedman, Jerome H.; Pripstein, Morris; Ross, Ronald R. (Univ. of California, Berkeley). Phys. Rev. Lett., 22: 200-3(Feb. 3, 1969).

The production angular distribution of the reaction $K^-p \to Y_1^{*+}(1660)\pi^-$ around 2.6 GeV/c, measured by using the $(\Sigma\pi)^+$ and $(\Sigma\pi\pi)^+$ decay modes, is interpreted as evidence for two distinct $Y_1^*(1660)$ resonances. (auth)

13035 THE MAGNITUDE AND SIGN OF THE $K_L - K_S$ MASS DIFFERENCE. Canter, Joseph Marshall. Pittsburgh, Carnegie-Mellon Univ., 1968. 134p.

Thesis.

Two experiments have been performed to measure the mass difference Δm between the long and short-lived neutral K mesons. The data were obtained at the Alternating Gradient Synchrotron from three exposures of the Brookhaven National Laboratory 30-inch bubble chamber, filled with deuterium, to a beam of 600 MeV/c positive K mesons. K^0's were produced by the reaction $K^+d \to K^0pp$, and the mass difference was measured by monitoring the time dependence of subsequent strong interactions of the neutral K's. In one experiment, the magnitude of Δm was measured by studying $\bar{K}^0$ interactions that lead to the decay $\Lambda \to \pi$-p. 165 events were found which satisfied appropriate selection criteria and the likelihood function for Δm was constructed. This yielded the value $|\Delta m| = 0.65 \pm 0.14$, in units of inverse K_S lifetimes, in agreement with determinations of the mass difference by other methods. In an analogous experiment, the time dependence of neutral K elastic scatters followed by the decay $K_S \to \pi^-\pi^+$ was studied. 120 events were found, divided into three categories: scatters on neutrons, protons, and deuterons. Present information on the scattering amplitudes for these processes is discussed. It is shown that they are sufficiently well-known for our data to give conclusive evidence that the mass of the long-lived state is greater than that of the short lived one. (Disser. Abstr.)

13036 LOW ENERGY K^--P ELASTIC INTERACTION. Thomas, Gerald Paul. Buffalo, State Univ. of New York, 1968. 127p.

Thesis.

The elastic interaction of K^- mesons with protons in the 0–250 MeV/c momentum range was investigated in nuclear emulsion. The K^- beam was obtained at the Berkeley Bevatron. It had a flux density of about 1.3×10^3 particles/cm². The momentum spread was approximately 50–350 MeV/c. The incident kaon average kinetic energy was ~30 MeV. The maximum angular divergence was ~35° with respect to the normal from the edge of the plate where the beam enters. A total of 29,000 stars were produced from K^- capture at rest and found from area scanning. All capture stars were carefully scrutinized for purposes of their identification. A total of 28,975 traces were made backward from the capture stars along the primaries in order to find elastic events. Out of a few hundred stars recorded, 54 stars appeared to be elastic events. After a range calibration was made for the emulsion, residual ranges were measured and kinetic energies and momenta were found from these ranges. Final selection of valid elastic events was made with the help of coplanarity and transverse momentum balance criteria. Thus 45 of the 54 apparent elastic events turned out to be valid K^-P elastic scatters. The experimental total elastic cross section was calculated and plotted against the momentum for the 0–240 Mev/c momentum range. It is seen from this plot that the elastic cross section fairly flat in the region of 80 MeV/c but rises sharply in the 20–40 MeV/c region. This disagrees with the latest emulsion experiment results in which the elastic cross section rises at a different value of the lowest momentum, i.e., ~80 MeV/c. These results agree fairly well with the other previous emulsion experiment results although their values of the elastic cross section do not go to as low values of kaon momentum as ours. A plot of the angular distribution of the scattered kaon as seen in the center of mass was made. From this, it was inferred that the scattering took place in the 1 = 0 channel. Therefore the S-Wave, Zero-Effective-Range parameterization theory was compared to the data of this experiment in order to investigate the values of the scattering length parameters. This theory is seen to be especially sensitive to the elastic cross section data in the 30–100 MeV/c region and adequately describes the K^-P interaction within the limits of our present data. The values of scattering length parameters chosen to describe the data indicate a somewhat less negative value for the ReA_0 scattering length parameter in comparison with previous results. These values tend to be more closely in line with the results of the dispersion relation approach of 0-Range theory. (Disser. Abstr.)

13037 THE $K\pi$ INTERACTION IN $K^+p \rightarrow K\pi\pi^+p$ AT 7.3 GeV/c AND Ξ^- PRODUCTION IN K^-p INTERACTIONS AT 2 GeV/c. Trippe, Thomas Gordon. Los Angeles, Univ. of California, 1968. 142 p.

Thesis.

An analysis of the $K\pi$ interaction in the reactions: $K^+p \rightarrow K^+\pi^-\pi^+p$ (1a), and $K^+p \rightarrow K^0\pi^0\pi^+p$ (1b) is presented. 3735 examples of reaction (1a) and 778 of (1b) were obtained from an exposure of the Brookhaven National Laboratory 80 in. Bubble Chamber to a beam of 7.3 GeV/c K^+ mesons. Reaction (1a) is discussed in detail. A cross section of 1.75 ± 0.15 mb is obtained for reaction (1a). Copious $K^{*0}(890)$ and $\Delta^{++}(1236)$ production are observed. The π^+p scattering angular distributions obtained from reactions (1), assuming OPE (one-pion-exchange) are compared with real π^+p scattering data. Similarly obtained $K\pi$ angular distributions are used to investigate $K\pi$ scattering. An OPE model with off-mass-shell vertex factors proposed by Dürr and Pilkuhn is shown to describe the momentum transfer distribution of $K^{*0}\Delta^{++}$ production from 3 to 13 GeV/c. This model is applied to reaction (1a) over a $K\pi$ mass range from threshold to 1.9 GeV. The results indicate that the $T = \frac{1}{2}$ s-wave $K\pi$ scattering length is 0.34 ± 0.007 fermi, and that the corresponding phase shift $\delta_{S_{1/2}} \sim 90$ at ~1.1 to 1.2 GeV. The $K\pi$ moments are shown to be qualitatively consistent with a broad $T = \frac{1}{2}, 0^+$ $K\pi$ resonance centered in this mass region. Based on the present best candidates for the scalar meson nonet, SU^3 symmetry predicts a $0^+K_V(1100)$. Also a study of the reactions $K^-p \rightarrow \Xi^-K^+$ (2a), $K^-p \rightarrow \Xi^-K^0\pi^+$ (2b), and $K^-p \rightarrow \Xi^-K^+\pi^0$ (2c) is given. The data were obtained from an exposure of the Lawrence Radiation Laboratory 72 in. bubble chamber to a beam of 2.0 GeV/c K^- mesons. Cross sections of 98.1 ± 5.9, 76.4 ± 4.6, and 36.2 ± 3.3 μb are obtained for reactions (2a), (2b), and (2c), respectively. Cross sections for $\Xi^{*0}K^0$, $\Xi^{*-}K^+$, and Ξ^-K^{*+} production of 55 ± 9, 20 ± 5, and 21 ± 4 μb, respectively, are found. In reaction (1a) the Ξ^- polarization P is studied as a function of production angle. A partial-wave analysis is also performed. The Legendre-polynomial expansions of $d\sigma/d\Omega$ (coefficients A_l) and $Pd\sigma/d\Omega$ (coefficients B_l) have significant contributions for A_1, A_2, A_3, B_1, B_3, and one isolated higher-order moment, A_6. The partial-wave equations are solved by a search technique for $S_{1/2}$, $P_{1/2}$, $P_{3/2}$, and $D_{3/2}$ amplitudes using A_l and B_l with $l \leq 3$. Four similar solutions and their generalized-Minami transforms ($T_{j=l+1/2} - T^*_{j=l-1/2}$) are found. The isolated A_6 term may be understood as due to a small $J \geq \frac{5}{2}$ amplitude interfering with one of the $J \leq \frac{3}{2}$ amplitudes. This may indicate that the spin of the $\Sigma(2250)$, seen in total K^-p and K^-d cross section experiments, is $>\frac{3}{2}$. A baryon-exchange interpretation of Ξ^-K^+, Ξ^0K^0, and Ξ^-K^0 cross sections at lower momenta gives a ($T = 0/T = 1$) isotopic spin ratio of (7.0 ± 2.3) for the exchanged baryon. A naive interpretation of these results using absorption calculations by Donohue and Jackson suggests $J = +\frac{3}{2}$ or $-\frac{1}{2}$ for the spin of the exchanged object. The Ξ^{*0} and Ξ^{*-} production angular distributions are presented. (Disser. Abstr.)

13038 MEASUREMENT OF K_2^0–p TOTAL CROSS SECTIONS AT LOW ENERGIES. Sayer, Gustav Andrew. College Park, Md., Univ. of Maryland, 1968. 116p.

Thesis.

The total cross sections of K_2^0's on protons are measured in the momentum range 168–343 MeV/c. The results are analyzed in terms of the zero-effective range theory of Dalitz and Tuan. An independent determination of the T = 1, $\bar{K} - N$ scattering length is made. This is then compared with the scattering length results of K^--p experiments. (Disser. Abstr.)

13039 THE INTERACTION BETWEEN 610-MeV/c POSITIVE PIONS AND HELIUM. Head, James Howard. Lawrence, Kan., Univ. of Kansas, 1968. 108p.

Thesis.

In the energy interval up to a few hundred MeV, the interaction of pions with nuclei has been investigated in a number of experiments, however the results were mainly of a qualitative nature owing to poor statistical accuracy. The basic purpose of this work was to perform a systematic investigation of inelastic processes occurring in the π^+-^{4}He interaction. The major effort was to accumulate sufficient data to check various phenomenological models of double charge exchange and pion absorption and to investigate the effect of resonance formation in the final state. The data were obtained from 17,300 frames exposed in the ANL-CIT 10" helium bubble chamber. The events were measured on a conventional film-plane digitizing projector, and processed through standard spatial reconstruction (NP54) and kinematical fitting (GRIND) programs. All physically allowable hypotheses were tested. Partial cross sections were determined for the following processes: elastic scattering, inelastic scattering (both with and without charge exchange), nonradiative capture, pion production, and double charge exchange. The differential elastic cross section was found to be in agreement with the predictions of both the strong absorption model, and Glauber's multiple scattering model. Formation of excited states of ^{4}He, reported by other authors, was not detected in the present experiment, which probably means that these states cannot have natural parity. The angular distribution for inelastic scattering was found to be in reasonable agreement with the impulse approximation, and the momentum and angular distributions of the spectator nuclei were consistent with this model. Formation of the N* pion-nucleon resonance was seen to be important in final states resulting from large momentum transfer collisions, in which the nucleus was broken into three or more fragments. A detailed investigation of the nonradiative capture process indicated that the dominant mechanism was the absorption of a pion by a pair of nucleons, with two spectator nucleons. Further the rate for pion capture by a n-n pair was determined to be equal to that for capture by a p-n pair, indicating that the matrix element for pion capture by two nucleons is essentially spin and isospin independent. The double charge exchange reaction was found to be similarly dominated by a pion–two nucleon interaction and the resulting momentum and angular distributions were in good agreement with a simple phase space model. Structure was observed in both the dipion and dibaryon effective mass distributions from several final states. However the enhancements observed were of low statistical significance and there is no conclusive experimental evidence in favor of resonance formation in either of these systems. (Disser. Abstr.)

13040 SIX-PRONG EVENTS PRODUCED IN 16 GeV/c π^-p INTERACTIONS. Junkmann, B. (Technische Hochschule, Aachen); Keppel, E.; Kraus, G.; (and others). Nucl. Phys., B8: 471-84(1968).

About 12,000 events with six prongs have been measured in 16 GeV/c π^-p interactions. Cross sections for the various reaction channels and for the production of mesonic and baryonic resonances are given. In the reaction $\pi^-p \rightarrow p\pi^+\pi^+\pi^-\pi^-\pi^-$, the $(\pi^-\pi^-\pi^+)$ effective mass spectrum shows indications of enhancements near the A_1, $A_{1.5}$ and A_2-meson masses. The longitudinal momentum distributions and the average transverse momenta are presented. The distribution of the angles between pairs of pions is studied and it is shown that in π^-p interactions the average opening angle for pairs of positive pions is smaller than that for pairs of negative pions. (auth)

13041 $Y_0^*(1520)$ PRODUCTION AND DECAY IN THE REACTION $K^-n \rightarrow Y_0^*(1520)\pi^-$ AT 3 GeV/c. Scheuer, J. C. (CEN, Saclay, France); Merrill, D.; Verglas, A.; (and others). Nucl. Phys., B8: 503-10(1968).

The decay branching fractions of the $Y_0^*(1520)$ were measured, and the production processes in K^-n interactions at 3 GeV/c were investigated. (auth)

13042 THE $K^-n \rightarrow K^-\pi^-p$ REACTION AT 2.24 GeV/c. Galloway, K. F.; Alyea, E. D. Jr.; Chandler, J. P.; Crittenden, R. R.; Martin, H. J. Jr. (Indiana Univ., Bloomington). Nucl. Phys., B8: 545-52(1968).

The reaction $K^-d \rightarrow K^-\pi^-pp$ was studied at 2.24 GeV/c. The observed features of the reaction are consistent with an impulse approximation model and represent the reaction $K^-n \rightarrow K^-\pi^-p$. Both the (π^-p) and (K^-p) systems show resonance production. Decay distributions for the $Y_0^*(1520)$ are presented. Cross sections are also given. (auth)

13043 LIGHT FRAGMENTS WITH Z ≥ 4 EMITTED IN THE INTERACTION OF 1.5 GeV/c K^- MESONS WITH Ag AND Br NUCLEI. Juric, M.; Popov, S. (Inst. of Physics, Belgrade). Nucl. Phys., B8: 565-72(1968).

Some experimental data concerning the production of hyperfragments and fragments with Z ≥ 4 in the interaction of 1.5

GeV/c K^- mesons with emulsion nuclei are given. Fragment and hyperfragment production rates are found to be $(1.20 \pm 0.13)\%$ and $(0.10 \pm 0.02)\%$ respectively. The production characteristics are studied. (auth)

13044 RECENT DEVELOPMENTS IN BOSON RESONANCES. Goldhaber, Gerson; Goldhaber, Sulamith (Univ. of California, Berkeley). Advan. Particle Phys., 2: 1-174(1968).

A review is given of research on boson resonances. This review includes quantum number determination and an experimental survey of the boson resonances. (J.F.P.)

Particle Interactions and Properties (Theoretical)

General

13045 (COO-264-469) THEORETICAL RESEARCH IN ELEMENTARY PARTICLE PHYSICS. Technical Progress Report, April 1–December 1, 1968. Nambu, Y. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies). Dec. 13, 1968. Contract AT(11-1)-264. 19p. Dep. CFSTI.

Research is outlined and a bibliography of published works is presented. (W.H.K.)

13046 WEAK SELF-MASSES AND CABIBBO ANGLE. DISCUSSION OF HIGHER ORDERS. Gatto, R. (CERN, Geneva).; Sartori, G.; Tonin, M. Nuovo Cim., Lett., 1: 1-14(Jan. 1, 1969).

An argument was previously presented relating the value of the Cabibbo angle to the symmetry breaking of chiral SU(2) × SU(2). The argument was based on the requisite that there should be no quadratic divergent contributions to a general second-order matrix element for emission and reabsorption of a W-boson. Higher-order contributions are discussed, and it is shown that in the quark model the argument applies at any order. The fourth-order derivation is derived for the more general case, employing Bjorken's technique to relate the coefficients of the divergent terms to equal-time commutators. (L.B.S.)

13047 ASYMPTOTIC EQUALITIES OF CROSS-SECTIONS OF MULTIPLE FORMATION. Nguyen Ngoc Thuan (Joint Inst. for Nuclear Research, Dubna, USSR). Ukr. Fiz. Zh., 13: 1768-73 (1968). (In Russian).

Asymptotic equalities are obtained of the cross sections of the multiproduction cross-processes $a + b \rightarrow a_1 + a_2 + \ldots + a_n + b'$ and $\tilde{a} + b' \rightarrow \tilde{a}_1 + \tilde{a}_2 + \ldots + \tilde{a}_n + b$ at fixed values of momentum transfer between b and b′ and effective mass of the system $a_1 + a_2 + \ldots + a_n$ or $\tilde{a}_1 + \tilde{a}_2 + \ldots + a_n$. (auth)

13048 EVIDENCE AGAINST THE TAMAID–BACH THEORY OF SUBNUCLEAR PARTICLE STRUCTURE. Swart, E. R. (University Coll. of Rhodesia, Salisbury). Chem. Ind. (London), No. 5, 126-31(Feb. 1, 1969).

Reference is made to the papers of D. T. Lewis on this theory (Chem. Ind. 729, 1146, 1173, 1301 (1968); Nature 216: 573, 784, 1199 (1967)), and it is stated that the theory as put forward is subject to numerous flaws which cast doubt on its viability. These doubts are discussed, and it is concluded that existence of the "bach" is unsubstantiated, and that even if it does exist its mass is almost certainly not that assigned to it by Lewis. A letter to the editor by S. A. Gregory on the "bach" mass is also included. (UK)

13049 RELATION BETWEEN THE PROJECTION OPERATOR FORMALISM AND THE FADDEEV THEORY. Grassberger, P.; Sandhas, W. (Univ., Bonn). Z. Phys., 220: 29-44(1969).

It previously was shown by means of the Faddeev equations that the reduction of the three-body problem to formal two-body equations with energy-dependent complex potentials—a procedure which was already well known for separable potentials—can be generalized rigorously to arbitrary potentials. It is shown that the projection operator approach of Feshbach appears as a special, and in a certain sense singular case of the general treatment. Optical potentials for rearrangement scattering are given explicitly and questions of how to calculate them are discussed, showing that the Faddeev approach is better suited in these respects. (auth)

13050 ADVANCES IN PARTICLE PHYSICS. VOLUME 2. Cool, R. L.; Marshak, R. E. (eds.). An Interscience Series. New York, John Wiley and Sons, Inc., 1968. 742p. $24.95.

The book contains five chapters. A separate abstract was prepared for each chapter. (J.F.P.)

For abstracts of individual chapters see: 13044, 13075, 13076, 13104, and 13115.

Electromagnetic

Refer also to abstracts 13071 and 13344.

13051 (ITEF-615) BREMSSTRAHLUNG AND THE DETERMINATION OF ELECTROMAGNETIC PARAMETERS OF PARTICLES. Zakharov, V. I.; Kondratyuk, L. A.; Ponomarev, L. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1968. 23p. (In Russian). Dep.

The possibility of determining electromagnetic multipoles of particles in processes with the soft γ-quanta emission is discussed. It is shown that the magnetic and the quadrupole moments of particles with the spin 1 and $^3/_2$ can be determined from the γ-quanta angular distribution in the radiative decays of these particles. It is also shown that in the case of radiative decays of resonances the γ-quanta emission by initial particles must be taken into account. (auth)

13052 (JINR-P2-4177) RADIATIVE CORRECTIONS TO π-e SCATTERING. PART I. Bardin, D. Y.; Semikoz, V. B.; Shumeiko, N. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of Theoretical Physics). 1968. 24p. (In Russian). Dep.

The radiative corrections to π-e scattering have been calculated for the experiment in which the energy and the angle of recoil electrons are measured. While studying the diagrams with two virtual γ- quanta exchange and those connected with the meson peak renormalization, strong interactions were not taken into account. It has been shown that the contribution of such diagrams does not exceed 1% in cross section, and it can be neglected if the account of strong interactions does not enlarge the contribution mentioned. In this case the electromagnetic form factor of π-meson can be taken into account in the cross section which includes the radiative corrections. The vital role of the angle measurement error is shown, that is a consequence of the kinematics of the process considered. (auth)

13053 (JINR-P4-4184) CALCULATION OF THE CORRELATION FUNCTIONS FOR THE SYSTEMS WITH FOUR-FERMION PAIR NEGATIVE INTERACTION. Bogolyubov, N. N. Jr. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 28p. (In Russian). Dep.

The problem of finding many-time correlation functions of any order for the model system with four-fermion pair negative interaction is being studied. (auth)

13054 (LNF-68/60) FIELD-CURRENT IDENTITY AND VACUUM POLARIZATION EFFECTS OF HADRONS. Note No. 416. Etim, E.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Oct. 17, 1968. 9p. Dep.

A simple method is presented for calculating fairly accurate vacuum polarization corrections of hadrons in $e^+ - e^-$ colliding beam interactions. Brief comments are made on the $\rho^0 - \omega$ interference in such processes as $e^+ + e^- \rightarrow \pi^+ + \pi^-$. (L.B.S.)

13055 VECTOR MESON COUPLINGS, ELECTRON SCATTERING, AND QUANTUM ELECTRODYNAMICS. Wilson, Richard (Harvard Univ., Cambridge, Mass.). Comments Nucl. Particle Phys., 2: 169-75(Nov.-Dec. 1968).

A review is given of results of recent measurements on the production of ρ, ω, and φ mesons in colliding beam experiments, π photoproduction on nucleons, and electron inelastic scattering on protons. Experiments for testing the validity of quantum electrodynamics are also briefly reviewed. (L.B.S.)

13056 DOUBLE PION PHOTOPRODUCTION WITH FORM FACTOR. Ciocchetti, G. (Istituto Nazionale di Fisica Nucleare, Turin. Laboratoire de l'Accelerateur Lineaire, Orsay, France); Ferroni, S.; Gracco, V. G. Nuovo Cim., Lett., 1: 21-6(Jan. 1, 1969).

The charge channel contribution $\gamma + p \rightarrow \pi^- + \Delta^{2+}$ to double pion photoproduction in hydrogen is considered. Previous models were found not to fit the experimental results. It is shown that a more complete agreement with experiment can be obtained by modifying the gauge-invariant extension of the OPE model by introducing a one-parameter form factor in the πNΔ vertex. Differential and total cross sections are calculated. (L.B.S.)

13057 PHOTOPRODUCTION OF NEUTRAL VECTOR MESONS AT HIGH ENERGIES IN THE REGGE POLE MODEL. Koval, L. N.; Matinyan, S. G. Yadern. Fiz., 8: 999-1001(Nov. 1968). (In Russian).

Photoproduction of the vector mesons on protons at high energies in the Regge pole model is considered which takes into account the exchange by tensor reggeons (f, f*, A_2) assuming U(3) symmetry and f and f* meson mixing. The suppression of φ meson photoproduction is obtained which is also valid at asymptotically high energies. (auth)

13058 ON PRODUCTION OF THE A_2-MESON IN ELECTROMAGNETIC PROCESSES. Shakhnazaryan, Yu. G. Yadern. Fiz., 8: 987-91(Nov. 1968). (In Russian).

Production of the A_2-meson in the reactions $e^+ + e^- \to A_2 + \pi$ and $e^- + \pi \to e^- + A_2$ is considered. Expressions for the cross sections are obtained and their dependence on the lepton polarizations is investigated. (auth)

13059 BREMSSTRAHLUNG AMPLITUDE FOR NUCLEON–NUCLEON COLLISION. Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 992-8(Nov. 1968). (In Russian).

Explicit expressions for the NN → NN γ reaction amplitudes in terms of the NN-scattering amplitudes and their derivatives are obtained in the Low approximation. (auth)

13060 WEAK INTERACTION EFFECTS IN THE SCATTERING OF MUONS AND ELECTRONS ON PROTONS. Lobov, G. A.; Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 971-7(Nov. 1968). (In Russian).

Previously made analysis showed that the Tanikawa–Watanabe renormalizable weak interaction theory can be in agreement with the cumulative data if the weak interaction $(\bar{e}e)(\bar{p}p)$ is stronger than the interaction $(\bar{e}\nu)(\bar{p}n)$. The calculations of P-odd correlations are given which appear in (ep) and (μp) scattering if the model is valid. The lower bound for P-odd effects turns out to be of 1% at the lepton energy 10 GeV and large momenta transfers. Real value of the effects may prove to be considerably larger. Because of that the theory is a renormalizable one, and its verification (in particular, search for considered P-odd effects) is of fundamental importance. (auth)

13061 PHOTOPRODUCTION OF W-MESON PAIRS. Kompaneets, V. G.; Folomeshkin, V. N. (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz., 8: 966-70(Nov. 1968). (In Russian).

An analytical expression for the cross section of the W-meson pair photoproduction is obtained. The cross section is given in the form of a double integral in the invariant variables. The analysis of the threshold behavior and of the asymptotics of the cross section is given. The numerical calculations are carried out for the mass values of 2, 2.5, and 3 GeV. (auth)

13062 VECTOR DOMINANCE MODEL AND THE PRODUCTION OF $\pi^\pm$ MESONS WITH POLARIZED PHOTONS. Bialas, A. (CERN, Geneva); Zalewski, K. Phys. Lett., 28B: 436-8(Jan. 6, 1969).

It is shown that the predictions of the vector dominance model agree reasonably well with the recent data on the production of π^+ and π^- mesons by polarized photons. The result is achieved by evaluating the ρ production data in the Donohue–Högaasen reference frame. (auth)

13063 ON THE SEPARATION OF INFRARED CONTRIBUTIONS TO RADIATIVE CORRECTIONS IN TERMS OF AN EXPONENTIAL FACTOR UNDER GENERAL EXPERIMENTAL CONDITIONS. Kohaupt, R. D. (Deutsches Elektronen-Synchrotron DESY, Hamburg). Nucl. Phys., B8: 627-37(1968).

It is shown that the usual splitting of infrared contributions to radiative corrections in terms of an exponential factor cannot be valid under general kinematical conditions. A modified formula is derived which avoids the shortcomings of the original formulation. The approximations made in this context are discussed in detail. (auth)

13064 CONJUGATE EQUATIONS OF CASCADE THEORY AND THE PERTURBATION METHOD. Kol'chuzhkin, A. M.; Shevtsova, I. N. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 143-5(1968). (In Russian).

Electron-photon cascades are formed on passage of high-energy particles through matter. A set of kinetic equations is given for the differential fluxes of the electrons and of the gamma quanta in the cascade in the form: $L\phi = S$. Here S is the distribution of external sources of electrons and gamma quanta (a two-component vector function); ϕ is the differential flux of electrons or gamma quanta, and L is a matrix element involving integral operators describing the scattering and generation of electrons and gamma quanta. The kernels of these operators represent the differential cross-sections of the corresponding processes (scattering, etc.). The readings of the detector I, placed in the radiation field, are determined by the formula: $I = (\phi,D)$. D is a function of the detector sensitivity. The functional I can also be expressed by a conjugate function. Changes in the functional ΔI are determined by the formulas of perturbation theory. The equations are useful in solving problems involving small perturbations. (TTT)

13065 LOW-ENERGY NUCLEON COMPTON SCATTERING. Koeberle, R. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 166: 1558-67(Feb. 25, 1968). (COO-264-390; EFINS-67-58).

In the case of nucleon Compton scattering, theory and experiment disagree at the photoproduction threshold and at the peak of the first pion-nucleon resonance (1236 MeV) at 90° c.m. scattering angle. Dispersion relations are used to calculate the scattering amplitudes of this process in the low-energy region in terms of the nucleon Born pole, photoproduction, π^0, and 2π exchange. Several currently accepted models for $I = J = 0$ $\pi\pi$ scattering are considered. Using a nonresonating or a resonating $\pi\pi$ phase shift with resonance width $\gtrsim 100$ MeV and position $\gtrsim 600$ MeV, one can account for the discrepancy between theory and experiment around the photoproduction threshold. At the 90° c.m. resonance peak, the situation remains essentially unchanged. (auth)

13066 ELECTROMAGNETIC FORM FACTORS OF NUCLEONS IN THE QUASI-INDEPENDENT QUARK MODEL. Shelest, V. P. (Inst. of Theoretical Physics, Kiev). Dokl. Akad. Nauk SSSR, 183: 555-61(Nov. 21, 1968). (In Russian).

It is assumed that baryons are strongly bound states of three fundamental particles — of quarks having a very large mass. The mass of the quarks is compensated by the large binding energy in the baryon. Effective quarks with a residual mass equal to one-third the mass of a baryon move in a self-consistent field in a quasindependent manner with no interaction between themselves. In this model the baryon is also a fermion with spin of $\frac{1}{2}$. Momentum transfer takes place by way of one of the component quarks. An explicit expression is obtained for the matrix element. It is found that the relations between the electromagnetic form factors of the baryons coincide with the experimental values. (TTT)

13067 OBSERVABLES IN THE BREMSSTRAHLUNG IN THE LOW APPROXIMATION. Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 1191-1200(Dec. 1968). (In Russian).

In the Low approximation components of arbitrary tensor for any processes accompanied by the emission of a soft photon are expressed as a linear combination of components of the analogous polarization tensor for the corresponding radiationless process. (auth)

Weak

Refer also to abstracts 13060 and 13061.

13068 ESTIMATE FOR PROBABILITIES OF DECAYS $K \to \pi e^+e^-$. Geidt, V. V.; Khriplovich, I. B. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 8: 960-5(Nov. 1968). (In Russian).

Probabilities of the decays $K^\pm \to \pi^\pm e^+e^-(\pi^\pm\mu^+\mu^-)$, $K_1 \to \pi^0 e^+e^-$ $(\pi^0\mu^+\mu^-)$ due to the weak and electromagnetic interactions are estimated. It is shown that the only role of the diagrams with the virtual Coulomb bremsstrahlung in the $K^\pm$-meson decays is to restore the transversity of the diagram with direct γ-quantum emission. Taking into account the baryon-antibaryon intermediate states the branching ratio of the $K^+ \to \pi^+e^+e^-$ decay is estimated to be $r \approx 10^{-7} + 10^{-6}$ that does not contradict the present experimental data. In so doing the assumption about the pole structure of the p-wave amplitudes of the nonleptonic hyperon decays is essential. For the $K_1 \to \pi^0e^+e^-$ decay an estimate $r \approx 10^{-9} + 10^{-8}$ is obtained. The $K_1 \to 2\gamma$ decay is also discussed. (auth)

13069 INTERFERENCE EFFECTS IN τ-DECAYS OF NEUTRAL K-MESONS. Anisovich, V. V.; Shekhter, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 8: 948-59 (Nov. 1968). (In Russian).

Interference term in the decay $K^0 \to 3\pi$ or $\overline{K}^0 \to 3\pi$ near the K-meson production point as well as the charge asymmetry in the decay $K_L^0 \to \pi^+\pi^-\pi^0$ are expressed in terms of parameters which determine the energy dependence of the τ-decay amplitude taking into account CP violation and the quantity ϵ which characterizes CP violation in the states K_S^0 and K_L^0. Investigation of the $K \to 3\pi$ decay allows one to distinguish between CP violation in superweak and milliweak interactions with $\Delta T = \frac{1}{2}$. (auth)

13070 CP VIOLATION AND τ-DECAY SPECTRA. Vitushkin, L. F. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 8: 942-7(Nov. 1968). (In Russian).

Difference between spectra of the decays $K^+ \to \pi^+\pi^+\pi^-$ and $K^- \to \pi^-\pi^-\pi^+$, $K^+ \to \pi^0\pi^0\pi^+$ and $K^- \to \pi^0\pi^0\pi^-$ due to the CP violation is calculated. (auth)

13071 $K_2^0 \to \pi^+\pi^-e^+e^-$ DECAY AND THE ELECTROMAGNETIC RADIUS OF THE $K_2^0 \to K_1^0$ TRANSITION. Zakharov, V. I.; Kondratyuk, L. A.; Ponomarev, L. A. (Inst. of Theoretical and

Experimental Physics, Moscow). Yadern. Fiz., 8: 983-6(Nov. 1968). (In Russian).

It is shown that in the lowest order in the 4-momentum of the (virtual) photon the matrix element of the $K_2^0 \rightarrow \pi^+\pi^-e^+e^-$ decay is expressed in terms of the matrix element of the $K_2^0 \rightarrow \pi^+\pi^-\gamma$ decay with the radius of the electromagnetic transition $K_2^0 \rightarrow K_1^0$ as a parameter. In this approximation various parameters of the $K_2^0 \rightarrow \pi^+\pi^-\pi^+\pi^-$ decay are calculated. It is shown that by measuring the decay probability which is about 10^{-6} of the total probability of the K_2^0-meson decay, the $K_2^0 \rightarrow K_1^0$ γ-transition radius can be approximately found. (auth)

13072 RADIATIONAL CORRECTIONS TO THE DECAYS $\Lambda \rightarrow N\pi$ AND $K_S^0 \rightarrow \pi^+\pi^-$. Belavin, A. A.; Narodetskii, I. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 978-82(Nov. 1968). (In Russian).

Radiational corrections to the relations due to the $\Delta T = ½$ rule for the decays $\Lambda \rightarrow p\pi^-$ and $K_S^0 \rightarrow \pi^+\pi^-$ are calculated. The contribution from the Coulomb term $\pi\alpha/\nu_{OTH}$ is shown to be substantial. The strong interactions are supposed to be switched off. (auth)

13073 COSMIC RAYS AT ULTRA HIGH ENERGIES (NEUTRINO?). Beresinskii, V. S.; Zatsepin, G. T. (Physical Inst., Moscow). Phys. Lett., 28B: 423-4(Jan. 6, 1969).

The neutrino spectrum produced by protons on microwave photons is calculated. A spectrum of extensive air shower primaries can have no cut-off at an energy $E > 3 \times 10^{19}$ eV, if the neutrino-nucleon total cross-section rises up to the geometrical one of a nucleon. (auth)

13074 ALTERNATIVE FORM OF ELECTRON–MUON UNIVERSALITY. Pilkuhn, H. (Univ., Karlsruhe, Ger.). Nucl. Phys., B8: 500-2(1968).

CP violation in K_{l3} decays could distinguish between two possible forms of electron-muon universality. (auth)

13075 NONLEPTONIC WEAK INTERACTIONS. Rosen, S. P. (Purdue Univ., Lafayette, Ind.); Pakvasa, S. Advan. Particle Phys., 2: 473-565(1968).

The review of nonleptonic weak interactions includes the general aspects of nonleptonic decay, isotopic spin in meson decay, selection rules in baryon decay, and the current interaction. (J.F.P.)

13076 CURRENT ALGEBRA. PART I. APPLICATION TO WEAK DECAYS. Mathur, V. S. (Univ. of Rochester, New York); Pandit, L. K. Advan. Particle Phys., 2: 383-471(1968).

The application of current algebra to weak decays covers equal time-commutation relations, PCAC, the Fubini-Furlan method for the Adler-Weisberger sum rule, semileptonic decays of hadrons, and nonleptonic decays. Emphasis is given to the arguments and calculational details. (J.F.P.)

Strong (General)

13077 MULTIPERIPHERALISM AND THE BOOTSTRAP. Chew, Geoffrey F. (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 2: 163-8(Nov.-Dec. 1968).

A brief survey is given of applications of multiperipheralism, together with the related hypothesis of multi-Regge poles. It is shown that the multi-Regge model in combination with unitarity implies a new class of bootstrap constraints on meson trajectories and couplings. (L.B.S.)

13078 FINAL STATE CLASSIFICATION AND NEW PHASE SPACE PLOT FOR MANY-BODY HADRON COLLISIONS. Van Hove, L. (CERN, Geneva). Phys. Lett., 28B: 429-31(Jan. 6, 1969).

The final states of hadron collisions at high energy are grouped in classes which generalize for many-body processes the distinction of two-body collisions into forward elastic, backward elastic and exchange processes. The use of longitudinal phase space plots is proposed for the phenomenological analysis of experiments and their comparison with dynamical models. The simple geometrical properties of these plots at high energy are pointed out. (auth)

13079 A NEW FORMULATION OF THE THEORY OF STRONG COUPLING. Ruijgrok, Th. W. (Univ., Utrecht). Nucl. Phys., B8: 591-608(1968).

Using the scalar symmetrical theory with a fixed and extended source as a model, it is shown how, in a simple way, the Hamiltonian can be written as $H = H_0 + gV$, where V is independent of the coupling constant g. The term H_0, which does depend on g, can easily be diagonalized. It is demonstrated that the effect of gV on the energy spectrum is small for large as well as for small g. The Schrödinger equation takes a form which allows not only the determination of extra terms in the asymptotic expansion of the energy, but also a fast and accurate numerical calculation for all values of the coupling constant. This makes it possible to compare and evaluate the one- and two-point Padé and other approximations. (auth)

13080 WAVE FUNCTIONS FOR THREE-BODY SYSTEMS. Karl, G.; Obryk, E. (Oxford Univ.). Nucl. Phys., B8: 609-21 (1968).

Polynomials constructed from the internal coordinates of a three-particle system are investigated. A prescription is given to count the number of homogeneous polynomials of the Nth degree which have a given angular momentum L, and definite behavior under permutation of the three particles. This number, as shown in the introduction, equals the number of corresponding states of energy $N\omega$ of a three-particle harmonic oscillator. Finally, an explicit procedure to construct a basis set of such polynomials is given. (auth)

13081 CORRELATIONS BETWEEN THE CROSS SECTIONS OF INELASTIC SCATTERING PROCESSES AT HIGH ENERGIES. Enkovski, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Ukr. Fiz. Zh., 13: 1563-4(Sept. 1968). (In Russian).

A large number of correlations for amplitudes and cross sections of strongly interacting high-energy particles are obtained on the basis of quark models or simultaneous commutation relations. Many of the relations are also the result of dispersion sum rules. Recently, using an assumption on the commutator structure of meson currents on the light cone S. Okubo (Physics, 3: 165 (1967)) developed relations for cross sections of pseudoscalar meson scattering processes. Based on the Okubo method, equations are developed for inelastic processes at high energies $P + B \rightarrow P + D$. The solutions were previously obtained using Regge pole theory and SU(3) symmetry which is the result of Okubo assumptions on the bond between hadron current algebra with the commutators on the light cone and the Regge pole theory. (R.V.J.)

13082 GENERALISED VENEZIANO MODEL FOR THE N-POINT FUNCTION. Chan, Hong-mo (CERN, Geneva). Phys. Lett., 28B: 425-8(Jan. 6, 1969).

A prescription is proposed for the explicit construction of a Veneziano-type formula for the N-point function where the external lines may have any (integral) spins. The resultant amplitude is expected to have the properties, analyticity, crossing symmetry, Dolen–Horn–Schmid duality, resonance poles on linear rising trajectories, and Regge asymptotic behavior in all Mandelstam channels. In addition, the model gives the decay correlations for particles with spin and treats all particles consistently as bound states of one another. So far the prescription has only been verified explicitly for N = 4, 5, 6 and 7, but it is believed to be of general validity. If taken seriously, it could provide the basis for a new phenomenology for virtually all hadronic processes. The explicit form for the 6-point function is given also as an example. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 13140.

13083 (ANL-HEP-6812) SYMPOSIUM ON NUCLEON-ANTINUCLEON INTERACTIONS, MAY 9, 1968. (Argonne National Lab., Ill.). 215p. (CONF-680533). Dep. CFSTI.

Separate abstracts are prepared for the seven papers included. (L.B.S.)

For abstracts of individual papers see: 13027, 13028, and 13084–13088.

13084 (ANL-HEP-6812,pp 4-16) $\bar{p}p$ ANNIHILATIONS AT REST. Gelfand, N. (Chicago Univ., Ill.).

Several properties of the $\bar{p}p$ system are briefly discussed. A summary is given of the results of pionic annihilations of stopped antiprotons. (L.B.S.)

13085 (ANL-HEP-6812,pp 17-57) REVIEW OF $\bar{p}N$ ANNIHILATIONS AT REST. Kalogeropoulos, T. E. (Syracuse Univ., N. Y.).

A review is presented of $\bar{p}N$ annihilations, which is based primarily on bubble chamber studies by the Syracuse-Rome collaboration. Some of the questions and conclusions concerning the spectator hypothesis, the S-capture hypothesis, and the triplet-singlet competition are discussed. Branching ratios for pionic annihilations, kaonic annihilations and the $\bar{p}N/\bar{p}p$ ratio are discussed. Data on pionic and kaonic annihilations are then reviewed. (L.B.S.)

13086 (ANL-HEP-6812, pp 58-78) TWO-BODY ANNIHILATION IN FLIGHT. Murphy, C. T. (Michigan Univ., Ann Arbor).

The data on $\bar{p}p \rightarrow \pi^+\pi^-$, $\bar{p}p \rightarrow K^+K^-$ and $\bar{p}p \rightarrow K^0\bar{K}^0$ annihilations above 200 MeV/c are summarized. Cross sections are given for annihilations into other two-body final states. (L.B.S.)

13087 (ANL-HEP-6812,pp 79-107) THEORIES OF $\bar{N}N$ ANNIHILATION: AN EXPERIMENTAL REVIEW. Cline, David (Wisconsin Univ., Madison).

The present theoretical understanding of $\bar{N}N$ interactions is discussed from the standpoint of problems which are subject to experimental clarification. The summary is divided into two parts, discussion of low energy $\bar{N}N$ interactions (below ~1 GeV/c $\bar{p}$ momentum) and a discussion of models that presumably apply at considerably higher momentum. (L.B.S.)

13088 (ANL-HEP-6812, pp 198-214) SOME THEORETICAL ASPECTS AND CONCLUDING REMARKS. Lipkin, H. J. (Princeton Univ., N. J. Palmer Physical Lab.).

Some theoretical aspects of $N\bar{N}$ annihilations are discussed. These include coherence and interference effects, t-channel amplitudes, symmetry predictions, and quark model predictions. (L.B.S.)

13089 MESON MASS SPECTRUM IN THE QUARK MODEL. Byckling, E.; Kallio, A. (Univ. of Oulu, Finland). Nuovo Cim., Lett., 1: 27-9(Jan. 1, 1969).

One of the features of the quark model is that the assumption of a mass splitting between the nonstrange and strange quarks gives a set of pseudoscalar and vector meson mass formulas. These are based on the assumption that the squared mass M^2 depends linearly on the splitting Δ and the coefficient of Δ is the same for pseudoscalar and vector mesons. The validity of this assumption is studied in the context of the Bethe–Salpeter equation for spin-$1/2$ particles. Results are also given on the dependence of the coupling constant of the quarks with the exchanged meson. (L.B.S.)

13090 DECAY MATRIX ELEMENTS FOR $f\pi$ DECAYING SYSTEMS AND DALITZ-PLOT DENSITY ALONG THE f^0 BANDS. Cantore, A.; Mandelli, L. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cim., Lett., 1: 33-8 (Jan. 1, 1969).

Decay matrix elements are calculated, using the formalism of angular momentum tensors, for the process $x \to y + \pi \to \pi + \pi + \pi$, where the meson x is assumed to have isospin I = 1, spin-parity J^P, and the meson Y isospin I = 0 and spin-parity $J^P = 2^+$. The abnormal-parity series and normal-parity series of angular momentum tensors are tabulated for various quantum-number assignments and definite orbital angular momenta. The averaged Dalitz plot density along the f^0 band is calculated for the series: 0^-, 1^+, 2^-, 3^+; 1^-, 2^+, 3^-. (L.B.S.)

13091 VENEZIANO'S MODEL AND NONET SCHEME FOR 1^- AND 2^+ MESONS. Kawarabayashi, K.; Kitakado, S.; Yabuki, H. (Kyoto Univ.). Phys. Lett., 28B: 432-5(Jan. 6, 1969).

Veneziano-type amplitudes for $\pi\pi$, πK, KK, and $K\bar{K}$ scattering are constructed and normalized at the ρ pole. S-wave scattering lengths are calculated in good agreement with those obtained by the method of current algebra, except for $K\bar{K}$ scattering. Present approach demands a nonet scheme for 1^- and 2^+ mesons. (auth)

13092 IMPORTANCE OF THE $\eta\pi$ DECAY MODE IN THE SPLIT A_2 DECAY. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel); Meshkov, Sydney. Contract NAonr 10-69. Phys. Rev. Lett., 22: 212-13(Feb. 3, 1969).

If SU(3) symmetry is assumed and singlet-octet mixing is neglected, (a) the $\eta\pi$ decay mode is forbidden for all negative CP states, (b) $\eta\pi$ cannot appear in decays where the $K\bar{K}$ mode is absent, and (c) the $\eta\pi/K\bar{K}$ branching ratio is the same for all isovector octet bosons allowed to decay into $\rho\pi$. Violation of these predictions would suggest serious re-examination of other SU(3) decay predictions. Prediction (b) seems to be violated by preliminary data. If there are no violations, and $\eta\pi$ and $\rho\pi$ are both allowed, the only possible classification for either A_2 peak with $J < 4$ is 2^{++}. (auth)

13093 DISPERSION CALCULATION OF THE $\pi-\pi$ SCATTERING LENGTHS. Nasrallah, N. F. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., B8: 622-6(1968).

Collinear dispersion relations are used to express the physical $\pi-\pi$ scattering amplitude at threshold in terms of the soft-pion results obtained from the current algebra. The scattering lengths are calculated and agree with those obtained by Schwinger on the basis of chiral dynamics. (auth)

13094 APPROXIMATE SOLUTIONS TO THE BETHE–SALPETER EQUATION AND THEIR APPLICATION TO THE THREE-PION PROBLEM. Cohen, Harold Lee. New Brunswick, N. J., Rutgers-The State Univ., 1968. 122p.

Thesis.

An approximation to the relativistic equation for three pions; the approximation leading to a Bethe–Salpeter equation for $\rho-\pi$ scattering in the one-pion-exchange approximation. After demonstrating how one obtains the $\rho-\pi$ equation from the 3π equation, an approximate solution to the Bethe–Salpeter equation is discussed for the case of spinless isoscalar particles scattering via the exchange of a third such particle, and the approximate results are compared with available, exact numerical results. Finding that the two sets of results compare reasonably well, this approximation is applied to the Bethe–Salpeter equation for $\rho-\pi$ scattering hoping to find the ω-meson as a bound state of this system. It is found that the binding is too weak to give an ω-meson. An improvement of our approximation is then discussed, showing how two seemingly dissimilar approximation schemes are related. Applying this improved approximation to the $\rho-\pi$ problem, a negative result is again obtained. Other uses of our approximation scheme are discussed. This technique is employed to demonstrate how one may obtain a reasonable solution to the original three pion problem. (Disser. Abstr.)

13095 O(4) SYMMETRY, $N\bar{N}$ SCATTERING, AND THE REGGE TRAJECTORY OF THE PION. Snider, Dale Reynolds San Diego, Calif., Univ. of California, 1968. 92p.

Thesis.

The $N\bar{N}$ Bethe–Salpeter equation is studied exploiting the O(4) symmetry of the scattering amplitude at t = 0. Spinor O(4) spherical harmonics are developed and used in the projection of the Bethe–Salpeter equation both at t = 0 and for small finite t. With the choice of Toller quantum number M = 1 for the pion trajectory at t = 0, as seems to be implied by high energy data, it is found that the M = 1 trajectory must mix with another trajectory near t = 0 in order to produce a physical pion. In addition, O(4) expansions are given for the $N\bar{N}$ helicity amplitudes for both equal and unequal mass. (Disser. Abstr.)

Strong (Baryon No. = 1)

Refer also to abstract 12536.

13096 DISPERSION SUM RULES FOR PION–BARYON BACKWARD SCATTERING. Volkov, G. G.; Ezhela, V. V.; Zamiralov, V. S. Yadern. Fiz., 8: 1020-8(Nov. 1968). (In Russian).

Superconvergent sum rules for pion-baryon scattering at u = 0 are presented. The Regge-pole asymptotics of the amplitudes are used in the derivation of the sum rules. With the resonance contributions into the s and t channels taken into account the vector and tensor ρ-meson-baryon couplings are obtained. The present results are in agreement with the SU(3) symmetry. (auth)

13097 ON POSSIBLE DECUPLET OF BARYONIC RESONANCES $5/2^+$. Gueret, P.; Enkovskii, L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 1042-3(Nov. 1968). (In Russian).

Possible existence of decuplet of baryonic resonances $5/2^+$ is considered. Decay rates of type $5/2^+ \to 1/2^+ + 0^-$ are calculated. The results are compared with the experiment. (auth)

13098 ALGEBRA OF CURRENTS AND PION PRODUCTION AT LOW ENERGIES. Vaidya, Arvind. Rochester, N. Y., Univ. of Rochester, 1968. 146p.

Thesis.

The principal objective of this work is to examine the consequences of the algebra of currents in relation to pion production at low energies. Assuming the commutation relations which hold in the σ-model we derive a low energy theorem on inelastic pion-nucleon scattering. The form of the single pion production amplitude thus derived is used in the physical region to calculate the production cross-sections. A limited amount of success is obtained for the numerical value production cross-sections. The threshold branching ratio predictions are also investigated. The method of effective Lagrangians, in particular the Lagrangian derived from the σ-model is considered in relation to the production process considered above. An infinite momentum sum rule is derived for N^* production in πN scattering. The relationship of the result to the usual SU_3 predictions is discussed. Application of the infinite momentum limit to the decay $\eta \to 3\pi$ is discussed. The photoproduction of pion pairs is examined on the basis of algebra of currents. Threshold branching ratios and estimation of cross-sections are done and the results are compared to predictions from other models. (Disser. Abstr.)

13099 QUARK-MODEL PREDICTIONS FOR JOINT DECAY DISTRIBUTIONS IN π^+p DOUBLE RESONANCE PRODUCTION REACTIONS AT 8 GeV/c. Aderholz, M. (Technische Hochschule, Aachen); Bartsch, J.; Deutschmann, M.; (and others). Nucl. Phys., B8: 485-99(1968).

The quark-model predictions of Bialas and Zalewski are compared with the experimental results for the joint decay distributions in the double resonance production reactions $\pi^+p \to N^{*2+}\rho^0$, $\pi^+p \to N^{*2+}\omega$ at 8 GeV/c. The relations fall into three categories, which differ in the assumptions made. Those of class A, which depend only on the additivity assumption, are found to be well satisfied for both reactions, within large errors. Similar agreement is found for relations of class B. A number of class C relations are badly violated in Jackson and helicity frames but are found to be valid in the Donohue–Högaasen system. (auth)

13100 LOWER HADRON STATES CLASSIFICATION AND SU(3) ⊗ SU(3) CHIRAL ALGEBRA APPROXIMATE SATURATION. Buccella, F. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); De Maria, M.; Tirozzi, B. Nucl. Phys., B8: 521-34(1968).

A classification scheme for hadrons is proposed, which fits well with the experimental π-N resonances. Under the hypothesis of SU(3) ⊗ SU(3) chiral algebra approximate saturation, G_A and $\alpha = D/D + F$ are evaluated in terms of the squares of the axial coupling constants; their value is in good agreement with experiment. Further model dependent predictions are obtained for the mixing angles of the baryon wave function and for the branching ratios of the predicted strange resonances. The values of the mixing angles are in agreement with what we expect from the e.m. structure of the nucleons. (auth)

13101 LOW-ENERGY PRODUCTION PROCESSES AND THE PION–PION INTERACTION. Humble, Stephen (Univ. of Colorado, Boulder). Nucl. Phys., B8: 695-704(1968).

The nucleon energy distribution of the three processes $\pi^-p \to \pi^+\pi^-n$, $\pi^-p \to \pi^0\pi^0n$, and $\pi^-p \to \pi^-\pi^0p$ near threshold are analyzed in terms of a model which includes the effects of both a T = 0 and T = 2 pion-pion final-state reaction. The data are insufficient to determine the T = 2 phase shift δ_2 accurately. Nevertheless, for reasonable value of δ_2, the T = 0 $\pi\pi$ phase shift δ_0 is found to be initially negative, with a scattering length $a_0 = -0.6 \pm 0.25\mu^{-1}$, but which soon turns up, become positive below 400 MeV. The model is tested further by calculating the energy distributions of one of the pions. The agreement found with the data is further evidence that δ_0 is probably of the turn-over type. (auth)

13102 REGGE-POLE MODEL FOR VECTOR MESON PRODUCTION. I. THE REACTION $\pi N \to \rho N$. Dass, Guru Vachan; Froggatt, C. D. (Atomic Energy Research Establishment, Harwell, Eng. Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B8: 661-85(1968).

The Regge-pole model of vector-meson production is discussed. Analyses of the reaction $\pi N \to \rho N$ with an evasive and conspiring Regge pion pole are contrasted. Contributions from the A_2 and ω Regge poles are included in the presented fits (to data between 2.7 GeV/c and 15 GeV/c lab momenta) which are similiar to those obtained from the absorption model. The decay correlations of the ρ-meson favor the conspiracy solution. Problems associated with factorization are pointed out. (auth)

13103 HARD PIONS, CURRENT AND FIELD COMMUTATORS, AND LOW ENERGY PION NUCLEAR SCATTERING. Wray, Dennis A. (Oxford Univ.). Ann. Phys. (N. Y.), 51: 162-86(Jan. 1969).

Starting with assumptions about current and field commutators, Ward identities are derived for 3-point functions of the nucleon and meson. For 4-point functions reduced Ward identities are derived for the nonpole part of the amplitude. Combined with assumptions that vertex functions and nonpole parts of the amplitude are slowly varying in all 4-momenta, the same results are rederived as particle dominance in dispersion theory for vector and axial vector form factors, and predictions are obtained for the 8 low-energy πN scattering parameters in terms of 4 unknown parameters. The fit is in reasonable agreement with experiment and somewhat improved by considering explicitly N* contributions. The calculations show it is a good approximation to take the strong pion-nucleon coupling, $gF_s(K^2)$ as a constant. The pion mass is not set equal to zero. (auth)

13104 BARYON RESONANCES. Barbaro-Galtieri, Angela (Univ. of California, Berkeley). Advan. Particle Phys., 2: 175-381(1968).

Properties of resonant states involving baryons are reviewed, and the various methods used to find these properties are discussed. The strong interactions are mainly considered. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 13067 and 13104.

13105 DEUTERON POLARIZATION IN ELASTIC NUCLEON–DEUTERON SCATTERING. Ramachadran, G. (Indian Statistical Inst., Calcutta). Nuovo Cim., Lett., 1: 39-41(Jan. 1, 1969).

A theoretical description is presented of deuteron polarization in elastic nucleon-deuteron scattering within the impulse approximation framework, in an attempt to stimulate experimental studies at higher energies, where the approximation is generally believed to be valid. (L.B.S.)

13106 NON-MESIC MODES OF K^- ABSORPTION BY DEUTERONS. Reitan, Arne (Norges Tekniske Hoegskole, Trondheim, Norway). Ark. Fys. Seminar Trondheim, No. 1, 5p.(1969).

The nonmesic modes of K^- absorption by deuterons is considered in a phenomenological model. The kaon is assumed to be absorbed either directly by one nucleon, or by processes that involve exchange of one pion or kaon. (auth) (Norway)

13107 ABSORPTION OF LOW-ENERGY POSITIVE PIONS BY DEUTERONS. Reitan, Arne (Norges Tekniske Hoegskole, Trondheim, Norway). Ark. Fys. Seminar Trondheim, No. 2, 10p.(1969).

The reaction $\pi^+ + d \to p + p$ is studied at low energies. The calculated total cross section is compared with recent experimental results. (auth) (Norway)

13108 PHENOMENOLOGICAL ANALYSIS OF ELASTIC $\pi + d \to \pi + d$ SCATTERING. Doan-Nhuong (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 914-19 (1968). (In Russian).

A complete set of measurements (the differential cross section and deuteron polarization effects in the final state) is suggested for a direct reconstruction of the elastic $\pi + d \to \pi + d$ scattering amplitude. (auth)

13109 ON THE BINDING ENERGY OF A Λ-PARTICLE IN NUCLEAR MATTER. Ram, B.; James, J. R. (New Mexico State Univ., Las Cruces). Phys. Lett., 28B: 372-4(Jan. 6, 1969).

The binding energy D of a Λ-particle in nuclear matter is calculated using the recent central, spin dependent Λ-nucleon potential of Herndon and Tang. On the basis of the results obtained it is concluded that the effect of the three-body ΛNN forces in the calculations of D may be quite large. (auth)

13110 TOTAL CROSS SECTIONS OF HIGH-ENERGY PARTICLES ON ATOMIC NUCLEI. Abul-Magd, A. Y. (Atomic Energy Establishment, Cairo). Nucl. Phys., B8: 638-44(1968).

On the basis of Glauber's high-energy multiple-scattering theory, an approximate expression is obtained for the total cross sections of high-energy particles on atomic nuclei. This expression reproduces well the experimental data on the total cross section of proton-nucleus interaction in the multi-GeV energy range. Furthermore, it provides us with a criterion for the validity of the impulse approximation and the diffraction model for the treatment of high-energy collisions. (auth)

13111 ON THE npd VERTEX FUNCTIONS. D'Auria, R. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Predazzi, E.; Selleri, F. Nucl. Phys., B8: 645-53(1968).

It is shown that a reliable calculation of the npd vertex functions must take into account the effects on the form factors describing the NπN vertex with a virtual nucleon. These form factors are known with good accuracy in the region of interest. An explicit calculation shows that their effect is rather important and that the sum rules expressing the normalizability conditions of the deuteron wave-function are much better satisfied, in the anomalous region approximation, when such form factors are taken into account. (auth)

13112 EFFECTIVE-RANGE THEORY BASED ON THE N–S–B EQUATION. Mizouchi, Masayoshi; Murota, Toshiyuki; Noda, Matu-Tarow (Osaka City Univ.). Prog. Theor. Phys. (Kyoto), 40: 1079-86(Nov. 1968).

The effective-range theory is formulated based on the N-S-B equation, that is, the scattering length and the effective range are expressed by the zero energy solution of the N-S-B equation. The nucleon-nucleon scattering in the $^1S_0$ state is treated. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 13136 and 13304.

13113 (COO-1573-50) SPIN ALGEBRAS AND REPRESENTATIONS OF THE POINCARE GROUP. Braathen, Hans Joergen (Case Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Jan. 1969. Contract AT(11-1)-1573. 113p. Dep. CFSTI. Thesis.

The spin of an elementary particle is characterized in terms of the generators of the Poincaré group. A spin algebra, related to the canonical spin algebra is constructed from the generators;

the helicity operator is an element of this algebra, a second is constructed so that it commutes with the generator for a Lorentz transformation along the z-axis. A basis for a representation space is chosen in which the generators for space translations and this new spin algebra element are diagonal. The generators of the Poincaré group are represented in this new basis. The basis is proven to be equivalent to that defined by Kotański in which the crossing relations are diagonal. The representation has a number of peculiar properties which are discussed. A second basis is defined and an attempt is made to exploit the azimuthal symmetry in any scattering experiment. The Poincaré algebra is represented in this basis both for zero and non-zero mass. Singularities connected with the helicity convention are discussed. The discrete elements of the Poincaré group are represented in both bases and these bases are connected with the helicity basis defined by Jacob and Wick. Finally, the S matrix is constructed and the crossing relations are discussed. (auth)

13114 COUPLING OF SPACE-TIME AND INTERNAL SYMMETRY. Hegerfeldt, G. C.; Hennig, J. (Univ., Marburg, Ger.). Fortschr. Phys., 16: 491-543(1968).

The problem of obtaining nontrivial couplings of space-time symmetry and internal symmetry and the relationship of these symmetries considered as groups of operators in Hilbert space is examined. A review is given of some of the results which may be important for the solution of this problem. Section I deals mainly with mathematical investigations of embeddings of the space-time and internal symmetry groups and of their Lie algebras. Section II deals with mass splittings which are allowed by groups of restrictions not imposed. In section III, coupling of space-time and internal symmetry is discussed within the framework of Lagrangian field theory, axiomatic field theory, and S-matrix theory, respectively. (L.B.S.)

13115 BROKEN SYMMETRIES AND THE GOLDSTONE THEOREM. Guralnik, G. S. (Brown Univ., Providence); Hagen, C. R.; Kibble, T. W. B. Advan. Particle Phys., 2: 567-708(1968).

The discussion includes the Goldstone theorem, naturally occurring broken symmetries, gauge theories, and nonrelativistic broken symmetries. Also discussed are Goldstone bosons and composite fields, and symmetry-breaking effects in some noncovariant field theories. (J.F.P.)

Applications (Electromagnetic and Weak)

13116 RELATIONS BETWEEN THE CP-VIOLATION PARAMETERS IN A CURRENT-CURRENT MODEL. Gronau, M. (Tel-Aviv Univ., Israel). Nuovo Cim., Lett., 1: 30-2(Jan. 1, 1969).

An approximate relation is obtained between the independent CP-violation parameters η_{00} and η_{+-} in a model in which the hadronic part of the weak-interaction current contains scalar, pseudoscalar, tensor, and dual-tensor terms, in addition to the vector and axial vector terms. (L.B.S.)

13117 THE HADRONIC WEAK CURRENT REALIZATIONS OF SU(4) AND SU(6) LIE ALGEBRAS. Beckers, J. (Univ., Liege). Physica, 33: 737-45(1967).

With the object of obtaining sum rules for coupling constants such as the axial vector renormalized coupling constant g_A, explicit realizations of SU(4) and SU(6) algebras are constructed in terms of hadronic weak currents and in complete analogy with the models proposed by Wigner (SU_4) and by Gürsey and Radicati (SU_6). (auth)

Applications (Strong)

Refer also to abstract 13100.

13118 EXCHANGE DEGENERACY AND SU(3) FOR BARYONS. Capps, Richard H. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 22: 215-18(Feb. 3, 1969).

It is assumed that the contributions of baryon Regge trajectories cancel in the imaginary parts of meson-baryon scattering amplitudes in states of the SU(3) representations $\underline{10}^*$ and $\underline{27}$. Predictions concerning interaction ratios, mass splitting, and particle mixing are made and compared with experiment. (auth)

Field Theories

General

13119 ADDITIONAL EXPERIMENTAL PROOF OF CP NONCONSERVATION? WHO NEEDS IT? Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 22: 213-15(Feb. 3, 1969).

Experimental data are still consistent with Uretsky's model, which is CP invariant at the price of one extra neutral kaon which has no strong interactions but is degenerate with K^0 and $\bar{K}^0$ and mixes with them in weak decays. Long formal discussions of whether or not CP nonconservation is proved by present data are completely irrelevant as long as this model fits the data. CP nonconservation is presently accepted as the most reasonable interpretation of present data, not as an inevitable consequence. (auth)

Quantum Field Theory

Refer also to abstracts 13019 and 13114.

13120 (JINR-E2-4148) ANALYTIC REPRESENTATIONS OF TWO-POINT FUNCTIONS WITH NONCANONICAL LIGHT CONE SINGULARITIES. Lukierski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 24p. Dep.

The classes of analytic functions describing by means of its boundary values the sets of commutator functions with singularities $\delta^{(k)}(x^2)$ and $(x^2)_+^{-k}$ $(k = 1,2, \ldots)$ on the light cone are introduced. Their relation with the Kallen-Lehmann representation having nonintegrable spectral functions is given. The generalized wave renormalization constants, measuring noncanonical singularities, are introduced. The formulas exhibit in a clear way the light cone behavior and provide a proper scheme for studying the equal time limits. (auth)

13121 (JINR-E2-4166) SOME PROPERTY OF QUANTUM FIELDS AS OPERATOR-VALUED DISTRIBUTIONS. Kharatian, S. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 9p. Dep.

It is proved, that if we suppose quantum field $A_a(f)$ be an operator-valued distribution on some complete countably normed space $\Phi = \bigcap_{p=1}^{\infty} \Phi_p$, then $A_a(f)$ should necessarily be an operator-valued distribution on some Banach space Φ_p. (auth)

13122 (UCSD-10-P-10-46) SURVEY OF THE THEORY OF QUANTUM ELECTRODYNAMICS. Kroll, Norman M. (California Univ., La Jolla, San Diego). Sept. 1968. Contract AT(11-1)-Gen-10. 27p. (CONF-680934-2). Dep. CFSTI.

From Conference on Physics of the One and Two Electron Atoms, Munich, Germany.

A restricted definition is given of quantum electrodynamics, namely as a theory of spin-$\frac{1}{2}$ particles and photons which are free except for their interactions with one another and with an external electromagnetic field. The conceptual basis of the theory is discussed, followed by a survey of the applications of the theory and its technical problems. These include overlapping divergences, infrared divergence, bound state problems, and radiative corrections to electron scattering at high energies. Quantum electrodynamics at high energies is then reviewed. Speculations about future modifications of the theory are discussed. (L.B.S.)

13123 PHYSICAL INTERPRETATION OF QUANTUM ELECTRODYNAMICS. Dirac, P. A. M. Comment., Pontif. Acad. Sci., 2: No. 13, 1-12(1968).

The appearance of the infinities, high-energy cut-offs, the vacuum state, and the Heisenberg picture are discussed. Also, the normal order for calculating the Lamb shift and anomalous magnetic moment and its physical interpretation are considered. (W.H.K.)

13124 LAGRANGIAN APPROACH TO INFINITE COMPONENT FIELD THEORY. Watanabe, H.; Kamefuchi, S. (Tokyo Univ. of Education). Nucl. Phys., B8: 573-90(1968).

A Lagrangian formalism is constructed for a symmetric, traceless tensor (spinor-tensor) of rank N which describes a multiplet with spin 0, 1, 2, ..., $N(\frac{1}{2}, \frac{3}{2}, \ldots, N + \frac{1}{2})$. From physical quantities that are obtainable from this formalism the corresponding quantities for an infinite multiplet with integer (half-integer) spin are derived by means of an analytic continuation which changes the original field into a basis of an infinite-dimensional, unitary representation of the Lorentz group. Feynman rules for infinite multiplets are determined in this way. Within this formalism mass spectra of infinite multiplets are always of the Majorana type, and the difficulties related to the spin-statistics theorem and spacelike solutions do not arise. (auth)

13125 NEW SPECTRAL FUNCTIONS SUM RULES IN A QUANTUM FIELD-THEORY MODEL. Burnel, A. (Univ., Liege). Nucl. Phys., B8: 511-20(1968).

New spectral functions sum rules already known in the saturated form are derived from the identification of a neutral (axial) vector current with a four-components field describing simultaneously spin one and spin zero particles. (auth)

13126 CONSISTENT BOOTSTRAP IN THE AXIOMATIC FIELD THEORY. Al'tshuler, B. L. Yadern. Fiz., 8: 1052-5 (Nov. 1968). (In Russian).

In framework of the axiomatic approach simple conditions are formulated under which the particle states forming a complete set of asymptotic states correspond to the composite particles. The first condition is that the quasilocal terms should be omitted in the equations for matrix elements of the Heisenberg currents which are consequences from the Bogolyubov's causality relation. The second condition is that the S-matrix must satisfy the crossing symmetry. It is shown that these conditions determine in principle the spectrum of the particles present in the asymptotic states, and are equivalent to the conventional bootstrap conditions for the masses and the coupling constants if applied to the two-particle amplitudes in the pole approach. (auth)

13127 SOME APPLICATIONS OF RENORMALIZATION THEORY TO RELATIVISTIC BOUND-STATE PROBLEMS. Kafrissen, Edward. New Brunswick, N. J., Rutgers-The State Univ., 1968. 112p.

Thesis.

Some applications of an approach are studied which was suggested as a composite particle criterion: the vanishing of the composite particle wave function and vertex renormalization constants. In the first part of this thesis, a relativistic potential model is examined for which one can explicitly show the vanishing of the vertex renormalization constant (Z_1) is a bound state condition. This model consists of a Dirac particle scattering from a scalar potential. Alternate forms for Z_1 are derived by considering the Dirac equation in both coordinate and momentum space. Z_1 is identified as the Dirac Jost function evaluated at the bound state energy so that for this model the condition $Z_1 = 0$ is the usual condition for a bound state. In the second part of this thesis, a dispersion relation for the nucleon (nucleon, proton) wave function renormalization constant (Z_N) is shown to yield, in certain cases, a simple algebraic expression for Z_N. Taking the scattering amplitude due only to strong interaction forces, this expression for Z_N is evaluated and a result consistent with $Z_N = 0$ is found. Then introducing electromagnetic forces, which removes the strong interaction isotopic mass degeneracy, the possibility that $Z_p - Z_N = 0$ may yield the correct sign of $m_p - m_n$ is examined. (Diss. Abstr.)

13128 VACUUM FLUCTUATIONS AND SELF-ENERGIES IN QUANTUM ELECTRODYNAMICS. Tesser, Herbert. Hoboken, N. J., Stevens Inst. of Tech., 1968. 154p.

Thesis.

The methods of Kramers are applied to a modified version of the electrodynamics of Schoenberg, Rohrlich and Bergmann, yielding an electrodynamics free of mass renormalization. The Lorentz–Kramers' equations of motion for a first quantized particle interacting with a second quantized electromagnetic field are solved in the dipole approximation. For the free particle, the harmonic oscillator, and the particle in a uniform magnetic field, finite energies are obtained which are in agreement with the results of comparable renormalized theories. The role of charge fluctuations and Zitterbewegung in determining the response of a charged particle to the electromagnetic field is also investigated. It is shown that the Zitterbewegung and charge fluctuations introduce convergence at the Compton wavelength for the Lamb shift and anomalous magnetic moment of the electron. (Disser. Abstr.)

13129 CONSEQUENCES OF RENORMALIZABILITY IN QUANTUM ELECTRODYNAMICS. Rae, Anil Chandra. Ithaca, N. Y., Cornell Univ., 1968. 45p.

Thesis.

The photon propagator in quantum electrodynamics is studied in the high energy limit. The approach is to regulate the Feynman integrals which give contributions to the photon self-energy and then to use the fact that when an appropriate set of renormalization subtractions is made the resulting functions must be independent of the regulating mass. In addition, one makes the plausible assumption that the regulated functions are not singular in the limit where the electron mass approaches zero. To any finite order, one finds functional equations which must be satisfied by the various functions involved. These functional equations are used in two ways. The first is to find the possible form of the functions in each order of perturbation theory and relationships between the functions of different orders. It is found that in n^{th} order (in the fine structure constant α) the functions are specified by n constants (if $n > 1$); however, using the relationships between orders, (n-2) of these constants can be expressed in terms of the ones found in lower order. The second use of the functional equations is to assume that they may be summed to give information about the complete function. It is shown that the general function of two arguments is completely determined by two functions of a single argument. It will be recognized that the aim and methods of this work parallel those of studies of the renormalization group. The principal differences are a more explicit and careful discussion of the details of renormalization and a more complete study of the implications for the perturbation expansion. (Disser. Abstr.)

Gravitation and General Relativity

Refer also to abstracts 12506, 12507, 12510, and 12511.

13130 NOTE ON AN INTERESTING METRIC OF THE FIELD EQUATIONS IN GENERAL RELATIVITY. Bera, K. (Hooghly Mohsin Coll., West Bengal, India). J. Phys., A (London), 2: 138-9(Jan. 1969).

In the course of investigating the Rainich equations of the "already unified field theory" in the case when the electromagnetic field is nonstatic, Bera and Datta in 1968 obtained a metric which leads to empty flat space. It is shown that this metric is Riemannian (nonflat) and satisfies the field equations of gravitation for empty space. Hence it is of great interest from the point of view of cosmology. (auth)

13131 GRAVITO-INERTIAL FIELDS AND RELATIVITY. Coster, H. G. L.; Shepanski, J. R. (Univ. of New South Wales, Sydney). J. Phys., A (London), 2: 22-7(Jan. 1969).

Gravitational and inertial field equations of a Maxwellian form are established which lead to a consistent theory of gravitation. The new approach to dynamics arising from the field theory is in agreement with the theory of special relativity, while producing a fresh insight into some of the relativistic phenomena. (auth)

13132 PETROV CLASSIFICATION OF THE CYLINDRICALLY SYMMETRIC GRAVITATIONAL FIELD. Singh, K. P.; Singh, D. N. (Banaras Hindu Univ., India). J. Phys., A (London), 2: 28-33(Jan. 1969).

The most general cylindrically symmetric space-time is considered from the point of view of Petrov classification. The Pirani matrix is classified into six distinct cases. The Segre characteristics reveal that the cylindrically symmetric metric belongs to either Petrov type I or Petrov type II. It is also found that when the metric potentials are functions of time alone the space-time admits perfect fluid distribution. (auth)

13133 THE DOUBLE-SERIES APPROXIMATION METHOD IN GENERAL RELATIVITY. I. EXACT SOLUTION OF THE (24) APPROXIMATION. II. DISCUSSION OF WAVE TAILS IN THE (2s) APPROXIMATION. Hunter, A. J. (London Univ.); Rotenberg, M. A. J. Phys., A (London), 2: 34-49(Jan. 1969).

In 1966 Bonnor and Rotenberg used the double-series approximation method, in conjunction with the Bondi metric, to study gravitational radiation from an isolated cohesive axisymmetric source vibrating smoothly during a finite interval $u_1 \leq u \leq u_2$ (u = retarted time $t - r$). A complete solution, clearly convergent for $r > 0$ and all u, is given of the (24) approximation step of Bonnor and Rotenberg's work. The quadrupole–quadrupole interaction is shown to satisfy Huygens' principle, but the monopole-2^4-pole interaction gives rise to "wave tails". It is shown that, for $u > u_2$ (end of the source vibration), the "wave tails" resulting from the monopole-2^s-pole contribution of the (2s) approximation ($s \geq 2$) represent incoming 2^s-pole radiation, at any rate for $s = 2, 3, 4$. This confirms a result by Couch et al. (auth)

13134 AN OBSERVABLE PECULIARITY OF THE BRANS–DICKE RADIATION ZONE. Robinson, David C.; Winicour, Jeffrey (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev. Lett., 22: 198-200(Feb. 3, 1969).

It is pointed out that the Brans–Dicke theory predicts a transverse spin-0 component of the $O(r^{-1})$ radiative Riemann tensor. Unlike the conventional spin-2 radiative Riemann tensor, monopole oscillations may serve as a source. Under favorable conditions, neutron star formation within our galaxy will be detectable by Weber's gravitational-wave receiver. (auth)

Scattering Theory

Refer also to abstracts 12998, 13007, and 13011.

13135 (LPTHE-TH-68/13) PERIPHERALITY OF MULTIPLE PRODUCTION PROCESSES. Krzywicki, A. (Ecole Polytechnique, Paris (France). Laboratoire de Physique. Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Apr. 1968. 5p. Dep.

Strong dependence on momenta of secondaries of the phases of amplitudes for production processes has been recently uncovered.

It may be interpreted as reflecting the fact that secondaries are, classically speaking, created on peripheral trajectories. (auth)

13136 (LPTHE-TH-68/33) GROUP ANALYSIS OF SCATTERING AMPLITUDES. THE GROUP (SU(1, 1). Balachandran, A. P. (Syracuse Univ., N. Y. Dept. of Physics); Nuyts, J. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Sept. 1968. 11p. Dep. CFSTI.

An expansion for scattering amplitudes involving four particles of equal mass is proposed. It displays the dependence of the amplitude on all the Mandelstam variables and is intimately related to the Kotánski expansion in terms of transversality amplitudes. (auth)

13137 (NYO-3399-172) GENERALIZED MULTIPOLE EXPANSIONS. Balachandran, A. P. (Syracuse Univ., N. Y. Dept. of Physics. Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies); Nuyts, J. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies); Meggs, W. J. (Syracuse Univ., N. Y. Dept. of Physics. Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies); Ramond, P. (Syracuse Univ., N. Y. Dept. of Physics). Sept. 1968. Contract AT(30-1)-3399. 12p. (SU-1206-172; CONF-680809-42). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

The problem of expanding the elastic scattering amplitude of two spinless particles of equal mass is studied in terms of complete sets of functions which display their dependence on any two of the Mandelstam variables at once (remember that $s + t + u = 4\ m^2$). Two natural solutions are presented. In the first one, the set of functions is generated as the eigenfunctions of a partial differential operator which commutes with the total angular momentum operators in the three channels. The connection between these eigenfunctions and certain base vectors of the representation (σ,σ) of a suitably defined SU(3) is investigated. Crossing properties of partial wave amplitudes are derived. In the second solution, it is shown that the SU(1,1) group acts in a natural way on the momenta of a scattering event for which the direction of the 4-dimensional normal to the scattering hyperplane is fixed. This approach leads to expansions related directly to transversality amplitudes. Indications are given for generalizations of these ideas to the cases where the masses are different and the spins nonzero. (auth)

13138 INTEGRAL EQUATION FOR SCATTERING AMPLITUDES. Chew, G. F. (Univ. of California, Berkeley); Goldberger, M. L.; Low, F. E. Contract AF49(638)-1545. Phys. Rev. Lett., 22: 208-12(Feb. 3, 1969).

A dynamical scheme for studying Regge behavior of scattering amplitudes is outlined. It is based on unitarity and the concept of short-range momentum-space correlations in high-energy processes. (auth)

13139 MERCEDES GRAPH AS A SUPERPOSITION OF SIMPLER GRAPHS. Andersson, Bo (State Univ. of New York, Stony Brook). Nucl. Phys., B8: 654-60(1968).

It is proved that the Hankel-transform of the configuration-space function corresponding to the Mercedes graph can be written as a superposition of functions related to simpler graphs, i.e., with one or more lines missing. (auth)

13140 THE TOP POSITION OF THE LOOPS IN REGGE PARTIAL WAVES. Chiu, C. B.; Kotanski, A. (CERN, Geneva). Nucl. Phys., B8: 553-64(1968).

It is shown that the "top positions" for loops in the partial waves of a Regge amplitude depend sensitively on the presence of zeros in the amplitude near $t = 0$. For example, for an input Regge trajectory with slope 1 GeV^{-2}, the slope of the "top trajectory" (J versus s_{top}) for an odd signature amplitude is found to be ≈ 1 GeV^{-2} with nonsense-choosing mechanism at $\alpha = 0$, but is ≈ 0.5 GeV^{-2} with sense-choosing mechanism. The assumption that high-J low-mass loops are resonances is discarded since these high-J waves are expected to be unreliable. Also this assumption can lead to the violation of both the s-channel unitarity condition and the Froissart bound. From the consideration of phase factor, a top trajectory formula for the amplitude with nonsense-choosing mechanism is derived. The formula gives reasonable values for the top position over a wide range of s_0 values. For $\pi\pi \rightarrow \pi\omega$ case, using strong bootstrap assumptions together with this formula, one finds $\alpha_\rho(0) = 0.45$. This zero intercept is in a good agreement with linear extrapolation of physical meson masses assuming exchange degeneracy. It is argued, however, that this agreement is rather accidental. (auth)

13141 S-MATRIX FOR SCATTERING OF COMPOSITE SYSTEMS. Van Nieuwenhuizen, P.; Ruijgrok, Th. (Rijksuniversiteit, Utrecht). Physica, 33: 595-606(1967).

It is shown that the asymptotically stationary states, as introduced by Van Hove, provide a natural tool to describe the scattering of composite systems. The scattering problem is formulated in terms of these states and a unitary S-matrix is defined. The formal aspects are treated with complete mathematical rigor. The method can be used to derive an alternative form of the Faddeev equations. (auth)

13142 THEORY OF NON-RELATIVISTIC THREE-PARTICLE SCATTERING. Malfliet, R.; Ruijgrok, Th. (Rijksuniversiteit, Utrecht). Physica, 33: 607-19(1967).

A new method, using asymptotically stationary states, is developed to calculate the S-matrix for the scattering of a non-relativistic particle by the bound state of two other particles. For the scattering with breakup of this bound state, a simplified form of the Faddeev integral equations is obtained. It is then shown that all scattering processes without breakup of the bound state can be simply connected to the process where possible excitation or de-excitation of the bound state but no particle exchange occurs. The scattering amplitude for these processes satisfies a two-particle Lippmann–Schwinger equation with a compact kernel. It is in a form where all quantities have a clear physical meaning, so that it is well suited as a starting point for the application of approximation methods. (auth)

13143 VARIATIONAL METHODS IN SCATTERING THEORY. Joachain, Charles J. (Univ. Libre, Brussels). pp 61-86 of Symposia on Theoretical Physics and Mathematics. Vol. 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968.

From Symposia on Theoretical Physics and Mathematics, Madras. See CONF-670123.

The Hulthén–Kohn variation principle for determining phase shifts and scattering amplitudes is analyzed. The Schwinger variation principles, which are based directly on the integral equations of scattering phenomena, are then discussed. Finally, an introduction to the problem of minimum principles in scattering theory is presented. (L.B.S.)

Particle Accelerators

13144 (BNL-13120) SYNCHROTRON MAGNETS WITH CRYOGENIC EXCITING COILS. Danby, G. T.; Allinger, J. E.; Jackson, J. W. (Brookhaven National Lab., Upton, N. Y.). [1967]. 16p. Dep. CFSTI.

A brief description of high current density iron magnet performance is presented together with a summary of some parameters as applied to a 2-TeV machine lattice. (B.G.D.)

13145 (CERN-68-42) INDUCED RADIOACTIVITY IN THE EARTH SHIELDING ON TOP OF HIGH-ENERGY PARTICLE ACCELERATORS. Hoyer, F. E. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 9, 1968. 16p. Dep.

A study was made of the activity of radionuclides having half-lives longer than two days, that are produced in the Earth shielding of high-energy particle accelerators; the CERN 28 GeV Proton Synchrotron was taken as a representative example. Measurements were restricted to ^{22}Na and ^{45}Ca for reasons of counting techniques, chemical treatment, and relative hazard. Up to 2 pCi/g ^{45}Ca and 6.9 pCi/g ^{22}Na were measured. The concentrations determined at different locations were compared with calculations using experimental neutron flux data, and a good agreement of both values was found. It can be concluded from the measurements that no hazard exists as far as activity concentration of the effluent drainage water or manipulation of the Earth from the shielding during shut-down periods is concerned, at least when working conditions such as those of the CERN Proton Synchrotron at present are maintained. However, secondary particle fluxes increase considerably for improvements of proton intensity and target efficiency at 28 GeV/c proton energy or for a larger 300 GeV/c proton accelerator. For that case it can be shown from the data presented that a certain hazard due to ^{22}Na and ^{45}Ca concentration even for the effluent drainage water cannot be ruled out. (auth)

13146 (HASL-203) TABLES FOR THE DETERMINATION OF THE LATERAL SHIELDING REQUIREMENTS OF HIGH ENERGY ACCELERATORS. O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Nov. 1968. 72p. Dep. CFSTI.

Tables of barrier factors have been constructed to permit the rapid determination of neutron dose-equivalent rates transmitted through the lateral shielding of a proton or electron accelerator. Shield thicknesses range from 100 to 2000 g/cm^2, water concentrations range from 0 to 40% by weight. The tables apply to accelerated beams having energies greater than about 0.8 GeV. (auth)

13147 (JINR-P9-4138) PROBLEMS OF ELECTRON-ION RING STABILITY. Bonch-Osmolovskii, A. G.; Ivanov, I. N.; Iovnovich, M. L.; Makhan'kov, V. G.; Perel'shtein, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 9p. (In Russian). Dep.

Different types of instability of the electron-ion ring have been considered. Some parameters of a stable ring are pointed out. (auth)

13148 (JINR-P9-4171) ACCELERATING SYSTEM OF THE ION LOADED ELECTRON RING. Bonch-Osmolovskii, A. G.; Dolbilov, G. V.; Kolpakov, O. A.; Kuznetsov, A. B.; Mamonov, V. N.; Reshetnikova, K. A.; Rubin, N. B.; Rubin, S. G.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 23p. (In Russian). Dep.

Some theoretical aspects have been considered concerning the transverse accelerating system of the ring (of relativistic electrons rotating in the magnetic field) with a definite number of ions captured. The following problems are under study: ion capture by electrostatic field of the ring; accelerating system loading by the current of accelerated charges; motion and shape conservation of the ring in the accelerating system consisting of the magnetic field, alternative in space, and a number of high frequency phased resonators. (auth)

13149 (MORP-68-12) PARTICLE ACCELERATOR SAFETY MANUAL. (Brobeck (William M.) and Associates, Berkeley, Calif.). Oct. 1968. Contract PH 86-67-193. 127p.

For National Center for Radiological Health, Rockville, Md.

A manual providing guidelines for the control of radiation and nonradiation hazards associated with accelerators is presented. The particular types of accelerators covered in the manual are potential-drop accelerator (Van de Graaff, Cockcroft-Walton, Dynamitron, resonant Transformer, and insulating-core transformer), electron linear accelerators, betatrons, and cyclotrons. (B.G.D.)

13150 (SLAC-93) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, July 1–September 30, 1968. (Stanford Linear Accelerator Center, Calif.). Dec. 1968. Contracts AT-(04-3)-400; AT(04-3)-515. 77p. Dep. CFSTI.

A status report on the Stanford Linear Accelerator Project covering the period July 1, 1968 to September 30, 1968 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (auth)

13151 (TID-24915) PROTON–PROTON COLLIDING-BEAM STORAGE RINGS FOR THE NATIONAL ACCELERATOR LABORATORY. Design Study, 1968. (National Accelerator Lab., Batavia, Ill.). Contract AT(49-8)-3000. 105p. Dep. CFSTI.

A design study for proton–proton colliding-beam storage rings for the National Accelerator Laboratory is presented. Topics include choice of major parameters; lattice and orbit; magnet system; vacuum system; rf system; injection and beam transport; radiation, shielding, and beam dump system; monitoring and control systems; ring enclosures and experimental halls; support buildings and utilities and construction cost estimate. (B.G.D.)

13152 (UCRL-Trans-1385) SOME ESTIMATES OF WEAK INSTABILITY FOR COLLIDING PROTON BEAMS. Chirikov, B. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Berkeley, from Preprint 249. 24p. Dep. CFSTI.

Three examples of a certain mysterious, very slow instability of nonlinear oscillation are presented. A conjecture is put forward that the instability arises owing to diffusion along a network of intersecting stochastic layers (so-called Arnol'd diffusion). The criterion of stochasticity of resonance overlapping allows one to estimate the width of the stochastic layer as well as the diffusion rate. The border of strong instability is given by an expression which is in reasonable agreement with numerical and experimental results. For special initial conditions inside stochastic layers, an estimate for the slow diffusion rate due to high harmonic resonances is determined, and an equation for the essential harmonic number itself is given. The threshold above which Arnol'd diffusion becomes essential is practically independent of parameters. Above this threshold the particle's lifetime decreases for the majority of initial conditions as a result of combined action of Arnol'd diffusion and ordinary diffusion due to gas scattering or some other fluctuations in the accelerator. Arnol'd diffusion may be of importance for proton and especially antiproton storage rings. (auth)

13153 PARTICLE TRAJECTORIES IN INCLINED-FIELD ACCELERATION TUBES OF MINIMUM SECTION LENGTH. Gyarmati, B.; Koltay, E. (Inst. of Nuclear Research, Debrecen, Hungary). Nucl. Instrum. Methods, 66: 253-60(Dec. 15, 1968).

Numerical calculations to study the properties of the ion and electron trajectories formed in inclined-field tubes have been carried out in a simple approximation. The effect of the length of inclined-field sections on the amplitude of trajectory oscillations has been investigated and the minimum section length sufficient to retain the secondary electrons has been looked for. Decreasing the section length results in the simplification of the initial conditions and in a higher position stability of the accelerated beam. The programs used are suitable for any trajectory computation in the case of constant section length. (auth)

13154 DESIGN CHARACTERISTICS OF ELECTROMAGNETIC COMPENSATED EXTRACTION CHANNELS IN CYCLOTRONS. Mueller, R. W.; Berkes, B. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main. Abt. Kernenergie-Anlagen, Grosswelzheim, Ger.). Nucl. Instrum. Methods, 66: 309-15 (Dec. 15, 1968). (In German).

Combined ferromagnetic and electromagnetic shielding of the magnetic field is a convenient tool for extracting ion beams from cyclotrons, as regards the partially compensating interaction of the stray fields of both shielding components. The design of such combined systems (compensated iron channels) has been refined in order to give optimal compensation quality within small distances from the channel. (auth)

13155 MULTICHARGED HEAVY ION SOURCE FOR THE IPCR CYCLOTRON. Kohno, I.; Tonuma, T.; Miyazawa, Y.; Nakajima, S.; Inoue, T.; Shimamura, A.; Karasawa, T. (Inst. of Physical and Chemical Research, Yamato, Japan). Nucl. Instrum. Methods, 66: 283-8(Dec. 15, 1968).

An electron bombarded hot cathode type ion source was constructed for the IPCR 160 cm variable-energy cyclotron. The behavior of this source was investigated to determine the charge-state yield of ions for carbon, nitrogen and oxygen gases and to determine the parameters that effected these yields and source stability. The relative yields of multiple-charged ions were found to be critically dependent on the rate of gas flow, the arc voltage and the arc power. For the source stability, the alignment of the arc axis with the magnetic field was found to be important and it was effective to decrease undesired sparks and glow discharges in the source system. At present, ions of N^{4+}, N^{5+} and C^{4+} are accelerated to energies between 4 and 10 MeV per nucleon in the cyclotron and they are extracted to the beam transport system with intensities of a few μA. (auth)

13156 EFFECT OF THE ION EMISSION SURFACE ON THE OPTICAL PROPERTIES OF ION BEAMS. Davis, R. C.; Kelley, G. G. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 66: 224-8(Dec. 15, 1968).

The current density actually obtained in accelerated ion beams is much smaller than would be expected on the basis of the volume in phase space occupied by the ions leaving the source. A study was made of the trajectories of ions in a beam to find out the reason for this limitation in performance. In the cases studied the limitation could be laid entirely to the effect of the shape of the plasma emission surface. The accelerated beams had the coherence expected from the small thermal spread at the source, but the effective object resulting from the curvature of the plasma surface had an axial length of as much as 10 cm at high current with the result that only a small fraction of the accelerated current could be converged through a small aperture in image space. The effect of space charge in the beams was made negligible by neutralization. No other factor had an appreciable effect on beam optics. (auth)

13157 PRODUCTION OF A PARTIALLY POLARIZED 4.56-MeV NEUTRON BEAM USING THE ASSOCIATED PARTICLE METHOD. Tripard, G. E.; Monier, L. F. C.; White, B. L.; Martin, P. W. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods, 66: 261-9(Dec. 15, 1968).

The associated particle technique was used with the $D(d,n)^3He$ reaction to produce a highly collimated partially polarized 4.56-MeV neutron beam. A coincidence time resolution of 5 ns was obtained by using dual parameter pulse height analysis to correct for the kinematic variations in flight times of the ^3He particles. A rotating self-supporting thin film deuterated polyethylene target was used to reduce problems caused by elastically scattered deuterons from the target. A neutron beam intensity of 70 neutrons/sec · msterad was obtained at a deuteron bombarding beam current of 1.5 μA. The background count rate outside the neutron beam solid angle corresponded to a neutron flux of intensity 10^{-4} of that in the collimated beam. This beam to background ratio is high enough to allow the use of this method in small angle scattering experiments. (auth)

13158 SHIELDING OF MUONS AROUND HIGH ENERGY ELECTRON ACCELERATORS: THEORY AND MEASUREMENT.

Nelson, W. R. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 66: 293-303(Dec. 15, 1968).

The muon flux density and the absorbed dose rate that are produced when a high energy electron beam is completely attenuated in matter are calculated by integrating the muon pair production cross section over the photon distribution in the electromagnetic shower. Several cross section and photon track length formulae are examined. The Fermi–Eyges theory of multiple scattering is applied to the case of 1 to 20 GeV muons penetrating thick shields and the results are folded into the production theory. An 18 GeV electron beam was used to produce muons in order to verify the theory. The results indicate that the theory, even with multiple scattering included, does not correctly predict the shape of the angular dose rate distribution, although integration over the theoretical and experimental curves gives agreement within experimental error. (auth)

13159 1.6 GeV/c CHARGED PARTICLE SPECTROMETER FACILITY AT THE STANFORD LINEAR ACCELERATOR CENTER. Anderson, R.; Gustavson, D.; Prepost, R.; Ritson, D. (Stanford Linear Accelerator Center, Calif.). Nucl. Instrum. Methods, 66: 328-35(Dec. 15, 1968).

A 1.6 GeV/c spectrometer has been constructed at SLAC incorporating an n = 0, 90° bend, 254 cm radius magnet with second-order corrections. The magnet is of the window frame type allowing invariant focal properties up to 21 kG. It has a momentum resolution of ±0.08% and an angular resolution of ±0.4 mrad. It simultaneously focuses production angle and momentum from a 20 cm long target onto a single focal plane orthogonal to the beam direction allowing a considerable simplification in detecting a high energy scattering process. (auth)

13160 SIX-GAP BETA-SPECTROMETER FOR ON-LINE WORK WITH A CYCLOTRON. Spoelstra, B.; Rautenbach, W. L. (National Physical Research Lab., Pretoria). Nucl. Instrum. Methods, 66: 336-40(Dec. 15, 1968).

Special features are described of an iron toroidal beta-spectrometer built for on-line work with a cyclotron. (auth)

13161 SIMPLE TARGET THICKNESS MONITOR. Yang, Yu-tung (National Tsing-Hua Univ., Hsin-Chu, Taiwan). Nucl. Instrum. Methods, 66: 341-2(Dec. 15, 1968).

A simple crystal controlled marginal oscillator of 7 components has been designed for the purpose of monitoring the nuclear target thickness. The stability of the oscillator under vacuum with water cooling is ±1 cycle/h. No drift is observed within 4 to 5 h. The components are not critical except for optimum performance. The accuracy of target thickness measurement at 100 Å is about ±1%. (auth)

13162 AN EXPERIMENTAL DETERMINATION OF THE PHOTON YIELD FROM AN INTERNAL SYNCHROTRON TARGET. Raquet, E.; Timm, U. (DESY, Hamburg). Nucl. Instrum. Methods, 67: 309-17(Jan. 15, 1969).

This paper deals with the efficiency and other features of bremsstrahlung production on the internal target of an electron synchrotron. Effects of target thickness, primary energy and collimation are investigated and summarized by a semi-empirical formula. The results show that the photon yield is nearly independent of target thickness. The angular spread, however, depends rather strongly on energy. The target extension has been investigated; one can conclude that point targets may be used without loss of yield. The reduction of angular spread in the photon beam by use of a scraper is demonstrated. (auth)

13163 A NEW MODIFICATION OF THE COCKCROFT–WALTON VOLTAGE MULTIPLIER CIRCUIT. Goebel, W. Nucl. Instrum. Methods, 67: 331-6(Jan. 15, 1969).

By introducing a transverse coil in the middle of a Cockcroft–Walton multiplier, thus forming a resonant circuit in series with the capacitors of the condenser columns, the limit of the obtainable high voltage, given by Greinacher in the expression $V = nv_0$ can be far exceeded. The economy of the modificated cascade rectifier voltage multipliers seems to be better compared with conventional ones, which could be studied with a test model of 200 kV. The power factor was measured to be 1.0 and the overall efficiency to 76%. This gives new principles on the design of dc-accelerators with high power-output using Cockcroft–Walton multipliers. (auth)

13164 NEGATIVE HEAVY ION BEAMS. Dawton, R. H. V. M. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 67: 341-2(Jan. 15, 1969).

Negative ion beams of μA intensity have been obtained for the elements of Group IIIB and VB, and also for Be, Cu, Ag, Sn, Ta, W, Hg, and U. The beams were focused through a 5/32 inch aperture with a full angle of 1 in 25. (auth)

13165 NEUTRON TUBE WITH PENNING ION SOURCE. Chrusciel, Edward; Starzec, Antoni (Inst. of Nuclear Engineering, Krakow). Przegl. Elektron., No. 10, 461-7(1967). (In Polish).

A tube for generating fast neutrons from a reaction of the nuclear type designed in the Institute of Nuclear Engineering of the Mining and Metallurgical Academy in Cracow is described. The operating conditions of an ion source of the Penning type, selection of the deuterium storage, and measurement of the neutron flow rate to accessible targets are discussed. The tube can function at a pressure of $10^{-2} - 10^{-4}$ torr. The shape of the electrodes accordingly provides stable ionization conditions in the ion source and a wide beam of deuterons to the targets. Using targets of TiD and agalite targets, one may, without additional hazard, select electrodes of accelerating form. The metal connection made it possible to replace worn-out targets. Employment of an ion source with an incandescent cathode permitted use of a neutron generating tube as the detector in a voltage-doubling system. (JPRS)

13166 A METHOD FOR PRODUCING NEGATIVE ION BEAMS WITH ENERGIES BELOW 10 eV. Roche, A. E.; Goodyear, C. C. (Univ. of Liverpool). J. Phys., E (London), 2: 201-2(Feb. 1969).

An ion source and analysis system is described which yields beams of negative ions with a spread in energy of ±1.5 eV at maximum currents ranging from 5 pA at 5 eV to 0.5 nA at 100 eV. (auth)

13167 EXCITER CURRENT REGULATOR OF THE CYCLOTRON MAGNET AT THE JUELICH ISOCHRONOUS CYCLOTRON. Schadebrodt, G. (Allgemeine Elektricitaets-Gesellschaft AEG, Frankfurt am Main). Kerntechnik, 10: 669-72(Dec. 1968). (In English and German).

The power unit supplying the exciting current to the 700 t Juelich cyclotron magnet delivers 60 kW at 500 A with current fluctuations $<2 \times 10^{-5}$. It is connected to the 50 Hz threephase mains and has a regulator consisting of a thyristor bridge circuit and a magnetic error detector. The reference current is generated by a separate control circuit. Variations of the exciting current necessary for varying the particles energy are effected by changing the number of winding turns in the current comparator in fine steps. The switching-on time constant of the unit is so small that the build-up of the air gap field to a stable level is determined solely by decaying transients in the magnet core material. (auth)

13168 MAGNETIC GUIDING FIELD OF THE JUELICH ISOCHRONOUS CYCLOTRON. Thimmel, H. M. (Allgemeine Elektricitaets-Gesellschaft AEG, Frankfurt am Main). Kerntechnik, 10: 663-9(Dec. 1968). (In English and German).

The Jülich isochronous cyclotron is dimensioned as a multiparticle variable energy machine. The requirements imposed on the magnetic field of such a machine are discussed. The methods used for achieving the magnetic field, and the trajectory-dynamic properties of the field determined by field measurements, are described. (auth)

13169 SMALL-PARTICLE FOCUSING BY MEANS OF PLANE ELECTROSTATIC FIELDS. Shtepa, N. I. (Chernigov Pedagogical Inst., USSR). Zh. Tekh. Fiz., 38: 1060-6(June 1968). (In Russian).

Stokes' law is employed to study the focusing of statically electrified particles with a range of diameters of 10^{-1} to 10^{-4} cm. The focusing is effected by strong plane electrostatic fields. The differential equations describing the motion in the presence of gravitation and the resistance of the gas or liquid medium near the plane of symmetry are given. The focusing characteristic is found to depend on the particle size. The case with vanishing friction is analyzed in detail giving the thin-lens focal points, position of the image plane and transverse displacement arising due to gravity. The thin-lens analogy is extended to the case of a beam of particles moving in the viscous medium and the beam transformation parameters are calculated. It is shown in the analysis that the control of the beam transformation is possible by varying the field of the lens and particle velocity. (ATD)

13170 EXPERIMENTS ON PRODUCTION OF INTENSE HYDROGEN BEAMS. Dimov, G. I.; Kononenko, Yu. G.; Savchenko, O. Ya.; Shamovskii, V. G. Zh. Tekh. Fiz., 38: 997-1004(June 1968). (In Russian).

A pulsed arc hydrogen plasma beam source has been developed for generating negatively charged protons to be used in particle accelerators. It was found experimentally that the intensity of the plasma beam was strongly influenced by the nature of anode material, and that best results were obtained with an anode made from aluminum alloy D16. The intensity of the plasma current, electron density, and electron temperature in the plasma beam were determined with the aid of specially constructed probes, for which circuit diagrams are presented. A device for extracting the generated positive protons from the plasma beam and for the subsequent charge exchange of the extracted protons (i.e., conversion of positive protons to negative hydrogen ions) was constructed, and its schematic is included. With an initial positive proton beam of 1.5 A and a current density of 6 A/cm^2, the intensity of negative hydrogen ions was found to be 4.5 mA. The yield of negative hydrogen ions was limited by the defocusing effect on the initial proton beam by the space charge built up in the space between the plasma and the so-called suction electrode. (ATD)

13171 PHASE SHIFTER (Engineering Materials). (Standard Linear Accelerator Center, Calif.). (CAPE-1788).

14 drawings.

A phase shifter is described which is used as a part of a resonant ring test setup for inspection of high-power klystron windows. It is used to keep the ring resonant, to provide abnormally high microwave signals over 100 MW, and to determine if the windows are acceptable for installation in klystron tubes. (For details see TID-4100, Suppl 49.) (F.S.)

13172 POWER SUPPLY OF THE TRIMMING COIL SYSTEM OF THE JUELICH ISOCHRONOUS CYCLOTRON. Clasen, H.-J. (Allgemeine Elektricitaets-Gesellschaft AEG, Frankfurt am Main). Kerntechnik, 10: 673-7(Dec. 1968). (In English and German).

The power supply excites 36 pairs of trim coils mounted on the upper and the lower pole plates inside the air gap of the cyclotron magnet. Adjustments of the currents for an isochronous field correction and for a wedge error correction are carried out separately for each trim coil radius. In addition, the possibility exists for an automatic isochronous field correction by means of signals derived from an ion phase measuring device. (auth)

13173 THE INFLUENCE OF A PHONON BOTTLENECK ON THE DYNAMIC POLARIZATION OF PROTONS IN $(La,Ce)_2Mg_3(NO_3)_{12}.24\ H_2O$. Swanenburg, T. J. B.; Van den Heuvel, G. M.; Poulis, N. J. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 33: 707-33(1967).

In single crystals of $La_2Mg_3\ (NO_3)_2 \cdot 24\ H_2O$ containing 0.1 to 5% Ce the proton dynamic polarization factor as well as the polarization time have been measured. The results were compared with the predictions on the basis of Borghini's spin temperature theory including the influence of a phonon bottleneck. The dependence of the polarization factor and the polarization time on Ce concentration, temperature, microwave power and irradiation frequency is discussed. (auth)

13174 HIGH-ENERGY ACCELERATOR SHIELDING. Alsmiller, R. G. Jr.; Alsmiller, F. S. (Oak Ridge National Lab., Tenn.). Nucl. News, 12: No. 2, 47-9(Feb. 1969).

Shielding calculations for high energy accelerators are discussed. Nuclear reactions, charged particle–atomic interactions, charged pion decay with the formation of muons, muon decay, and radioactive residual nuclei are considered. Attempts to solve the nucleon–meson cascade equations are briefly outlined. (W.H.K.)

13175 PHASE ANALYZER OF BUNCHED ELECTRON BEAM. Takeda, Yasutsugu; Matsui, Isao (Hitachi Ltd., Tokyo). Jap. J. Appl. Phys., 8: 268-71(Feb. 1969).

A method is proposed for analyzing a phase distribution of electrons in a bunched beam. An electron beam from a buncher is led into a re-entrant cavity, in which the beam is deflected at a gap by a transverse electric field of the same frequency with that of the buncher. The deflection angle of electrons corresponds to their phases in the bunched beam; consequently, if electron collectors are set at different deflection angles, their output simulates the phase distribution of the electrons. A model experiment has been tried with a pre-buncher of a linac. The results are consistent with one-dimensional ballistic theory. When the pre-buncher was attached to a 6 MeV linac, the 45% increase of the output current was observed in good accordance with the estimation from the experimental phase-analysis. (auth)

13176 DIRECT EXPOSURE RADIOGRAPHIC TECHNIQUE FOR NEUTRON GENERATOR BEAM CENTERING. Persiani, C. (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Int. J. Appl. Radiat. Isotop., 0: 25-(Feb. 1969).

A technique for target alignment in a Cockcroft–Walton type of neutron generator is described. The method utilizes the direct exposure of standard industrial x-ray film and was found to be rapid and sensitive. (auth) (UK)

13177 THE 1.5-GeV SYNCHROTRON OF THE POLYTECHNICAL INSTITUTE OF TOMSK. Vorobev, A. A.; Volkov, M. N.; Visir, V. A.; Dvoretskii, M. I.; Didenko, A. N.; Krasnonosenkih, P. P.; Lashouk, N. A.; Chuchalin, I. P.; Shanin, P. M. (Polytechnical Inst., Tomsk, USSR). Nucl. Instrum. Methods, 66: 321-4 (Dec. 15, 1968).

The synchrotron construction and some experimental results from the synchrotron are described. A decrease of the pressure in the vacuum chambers from 1×10^{-5} Torr up to 3×10^{-6} Torr does not change the synchrotron intensity. As the pressure increases up to 8×10^{-5} Torr, the intensity becomes 8 times less and the vertical beam size increases. The electrons are accelerated by means of two cavities at a mean frequency of 36.46 MHz. It was established that the synchrotron intensity changes largely, if one cavity is distuned for +50 kHz from the resonance value. According to theory, the influence of the quantum character of the synchrotron radiation upon betatron oscillations was observed when the energy of the electrons is above 630 MeV. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 11900, 13157, 13165, 13266, 13306, 13313, 13576, and 13578.

13178 (CONF-671111–, pp 545-58) PROSPECTS OF TRANSURANIUM ISOTOPES AS NEUTRON SOURCES. Keller, O. L. Jr.; Ferguson, D. E.; Nichols, J. P. (Oak Ridge National Lab., Tenn.).

The method being used by the U. S. Atomic Energy Commission to produce the transplutonium elements, including californium, and the schedule of this production effort are discussed. These heavy elements are being produced for research that will involve their chemistry, nuclear properties, and uses such as medical research. The initiation of an activation analysis program at Oak Ridge National Laboratory with ^{252}Cf as the neutron source has therefore recently become possible. Calculations are presented for the expected sensitivity for the analysis of various isotopes of medical interest. A discussion of the containment and handling of the ^{252}Cf is given in conjunction with a description of the irradiation facility. (auth)

13179 (IEA–129) DETERMINATION OF ABSORPTION CROSS-SECTIONS OF MODERATORS BY THE METHOD OF PULSED SOURCES. Franzen, H. R. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov. 1966. 9p. (In Portuguese). Dep.

A pulsed-source technique for evaluating the neutron absorption cross sections of moderator materials is outlined. Results are presented for graphite and water. (D.C.W.)

13180 (JAERI–1170) RICM2: A CODE FOR SOLVING THE SLOWING DOWNS OF NEUTRONS OVER MANY RESONANCE LEVELS IN TWO-REGION LATTICES. Mizuta, Hiroshi; Kamei, Takanobu; Fukai, Yuzo (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). July 1968. 26p. Dep.

The computer program RICM2 for treating neutron slowing down over a wide energy range with many resonances in a two-region lattice is described. Expressions for various cross sections are presented, as are definitions of reaction rates, effective cross sections, and resonance integrals. A solution for the resonance flux in the lattice is outlined. (D.C.W.)

13181 (JINR–P3-4087) SOME POSSIBILITIES IN THE NEUTRON OPTICS. Matora, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1968. 10p. (In Russian). Dep.

The possibility of simultaneous polarization, double focusing, and monochromatization of a slow neutron beam in the nonuniform magnetic field of a six-pole sector magnet is demonstrated. The use of the magnetic field of a four-pole sector magnet together with the gravitational field in order to increase the efficiency of the so-called Maier–Leibnitz gravitational refractometer and to separate the particles with the zero magnetic moment from the neutrons is proposed. (auth)

13182 (RPI–328-142) LINEAR ACCELERATOR PROJECT. Annual Technical Report, October 1, 1967–September 30, 1968. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-28. 163p. Dep. CFSTI.

Separate abstracts were prepared for the six sections of the report. (D.C.W.)

For abstracts of individual sections see: 11900, 13183–13185, 13265, and 13576.

13183 (RPI–328-142, pp 68-116) FAST REACTOR PHYSICS: EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Electron-beam targets for pulsed-source time-of-flight studies of fast neutron spectra were investigated, and the energy-dependent efficiency of ^{10}B-vaseline and 20-in. proton-recoil detectors for fast spectrum measurements was determined. Position-dependent fast flux spectra were measured in rectangular Fe and depleted U assemblies and were compared with calculated spectra. Mean neutron emission times in U assemblies were investigated by calculating the first time moment for a depleted U assembly and by measuring position-dependent spectra from a pulsed depleted U assembly by the time-of-flight method. The kinetic behavior of fast assemblies was investigated in flux die-away experiments on a depleted U assembly. (D.C.W.)

13184 (RPI–328-142, pp 117-22) NEUTRON THERMALIZATION: EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Time-dependent neutron spectra were measured in the center of an externally pulsed 7.16 × 25.02 × 25.4 cm water medium at 37.8°C over an energy range of 0.01 to 0.25 eV. Time-dependent diffusion theory calculations were made using a 78-group Haywood-II + mass-16 free gas oxygen kernel with and without spatial harmonics. (D.C.W.)

13185 (RPI–328-142, pp 123-31) LOW-ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y.).

Major emphasis in the program during the past year has been on measurements and theory relating to hot H_2O (270°C) and room temperature UC; differential cross section measurements have been made in the energy range from 0.09 to 0.5 eV. Previous RPI measurements on UO_2 showed reasonable agreement with other work; therefore, emphasis has been placed on UC, for which no significant inelastic scattering measurements were previously available. In addition, the final cross section analysis on hydrides was completed and this phase of the program terminated pending a need for further moderator studies. Most of the work on Monte Carlo multiple scattering codes has been completed; the results will be used to correct the data for the measurements cited above. (auth)

13186 STATISTICS OF THERMAL NEUTRON CROSS SECTIONS. Musgrove, A. R. de L. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). J. Nucl. Energy, 22: 657-63(Nov. 1968).

The expected mean and variance of an unknown thermal cross section are calculated on the picket fence model and on an exact renewal theoretical model. The importance of the contribution from the first level is investigated; and, for cases where the position of the first resonance has been determined, the renewal theoretical approach to the calculation of the thermal cross section is outlined. (auth) (UK)

13187 EFFECTIVE BOUNDARY CONDITIONS AT THE SURFACE OF A BLACK ABSORBING ROD. Isakova, L. Ya. At. Energ. (USSR), 25: 229-31(Sept. 1968). (In Russian).

The effective boundary conditions at the surface of an absorbing rod may be derived by solving the diffusion and kinetic equations for conditions far from the rod, or on the basis of the neutron flow obtained from the kinetic equation or the diffusion approximation. The second method was used for the case of a black rod, placed in an infinite absorbing medium with a distributed neutron source. The infinite medium was replaced by a cylindrical cell, in the center of which was placed the black, absorbing rod; the S_8 approximation was used for calculating the neutron flow in the rod. The correlations between γ, the logarithmic derivative, expressed in transport lengths, on the radius of the rod, the absorption in the medium, and the parameters of the source are presented in tabular form and are compared with results of other authors and with averaged values reported in Reactor Physics Constants, ANL-5800. (TTT)

13188 NEUTRON GENERATING APPARATUS. Schmidt, Albrecht Carl (to Gesellschaft fur Kernforschung mbH). U. S. Patent 3,417,245. Dec. 17, 1968. Filed Apr. 22, 1963.

A gas discharge tube in which ions produced by a high-frequency low-pressure gas discharge are accelerated and undergo nuclear reactions in a target electrode for generating pulsed neutrons is described. (W.H.K.)

13189 THERMAL NEUTRON SPECTRA IN A POISONED D_2O/H_2O MIXTURE. Sinclair, R. N. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 22: 651-6 (Nov. 1968).

Thermal neutron spectra were measured in a poisoned D_2O/H_2O mixture in order to test the suitability of existing scattering kernels kernels for describing situations which occur in a spectral shift reactor. The mixture contained 50.55% D_2O and was poisoned with two concentrations of Cd (20.3 and 30.4 g/l). Spectra were measured by the neutron time-of-flight technique based on a pulsed neutron source provided by the 45 MeV Harwell electron linac. Flux distributions within the containment vessel were measured by irradiating Au–Mn alloy foils. The ratio of the two activities was found to be constant around the point of measurement and a diffusion theory code (SIMPH) was used for spectrum calculations. Spectra were calculated using a kernel in which the H_2 content was described by the Haywood model, the D_2 content by the Honeck model, and the O_2 content in the perfect gas approximation. Spectra calculated with this kernel agreed well with the observed spectra for energies greater than 0.04 eV, but some discrepancy (~10%) remained at 0.01 eV. (auth) (UK)

13190 PROBABILITY OF NEUTRON ABSORPTION IN A BLOCK IN THE UNRESOLVED ENERGY RANGE. **Pashkin, Yu. G.; Chekunov, V. V. At. Energ. (USSR), 25: 231-3(Sept. 1968). (In Russian).**

In some cases it is desirable to determine the resonance absorption probability in the range of unresolved levels for blocks consisting of mixtures of an absorber and a moderator; currently employed methods do not take into account the neutron absorption at higher levels. A solution was derived for this problem, considering the absorption during the moderation process for blocks which contain the absorber and scatterers with intermediate atomic weights, such as rare-earth elements or a dispersion of the absorber in a scattering matrix. For the calculations it was assumed that an unperturbed neutron flux fell on the absorbing block in an infinite scattering medium. The formula derived was demonstrated by applying it to the conditions prevailing in a 2-cm-diameter europium oxide rod. It was found that in the energy range examined, the absorption probability is decreased by 30% as a result of the leakage of the neutrons which were slowed down within the block. (TTT)

13191 PULSED-SOURCE INVESTIGATION OF THE EFFECT OF TRANSVERSE GAPS ON NEUTRON TRANSPORT IN A DIFFUSING MEDIUM. **Dance, Kerry Donald. Stanford, Calif., Stanford Univ., 1968. 210p.**

Thesis.

The objective of this work was to provide a systematic experimental basis for the analysis of neutron transport in void-containing media. The pulsed-source technique was employed, in which the rate of decline in neutron density in the experimental system, following the introduction of a burst of neutrons, is measured. This measured rate of decline (dieaway) can be related to the diffusion coefficient, which expresses the mobility of a neutron population. The experimental assemblies, chosen primarily for ease of analysis, were two identical, parallel graphite slabs separated by a single transverse gap. The analysis of the measurements included correction of the data for transient effects unrelated to the mobility of neutrons in systems at steady state, and provided the relation between the corrected dieaway rate and the apparent or effective diffusion coefficient of the voided medium. As in measurements in homogeneous systems, the asymptotic neutron decay was described by a single decay constant of the form $e^{-\lambda t}$. A theoretical analysis was developed which showed that while the time behavior of the population in systems with voids can not rigorously be described by a single decay constant, the neutron decay can be approximated very accurately by a single pseudo decay constant. The analysis also showed how the pseudo decay constants could be used to determine diffusion coefficients for use in steady-state situations. Specifically, a "time delay" correction was developed and was applied to the experimentally determined decay constants before they were used to determine diffusion coefficients. Diffusion coefficients appropriate for predicting steady-state leakage were determined both for a system of two slabs separated by a single transverse gap, and for a repeating array of slabs separated by void gaps. The results were obtained for void gap widths from 1 to 4 inches and for slab widths of 11.5 and 17.25 inches. (Disser. Abstr.)

13192 PULSED-SOURCE INVESTIGATION OF THE EFFECT OF CYLINDRICAL VOID CHANNELS IN A NEUTRON DIFFUSING MEDIUM. **Bull, Stanley Raymond. Stanford, Calif., Stanford Univ., 1968. 179p.**

Thesis.

A series of consistent experimental measurements were made of the neutron leakage from cavity-containing media, and an attempt was made to interpret the results in terms of effective diffusion coefficients. The technique employed was the pulsed-source method, in which the diffusion coefficient is inferred from the asymptotic decay constant curve. The ranges of pertinent variables (e.g., size and shape of the medium, cavity size, cavity spacing) were made large enough to afford a sound basis for checking the adequacy of various theoretical treatments of the problem. A review of the theories of Behrens, Carter, and Benoist is given. Benoist's theory includes provisions for computing the diffusion coefficient for finite media, as encountered in pulsed-source experiments and, consequently, was of greatest interest for comparison with experimental results. A versatile graphite assembly was chosen as the moderating and diffusing medium. With this assembly, solid graphite systems or lattices of cylindrical void channels with seven different combinations of channel spacing and size were constructed. In the course of the work, certain basic theoretical problems in relating pulsed-source measurements to the diffusion coefficient became apparent. These are discussed in the light of the results. (Disser. Abstr.)

13193 DIFFUSION PARAMETERS OF HETEROGENEOUS SYSTEMS AND SYSTEMS WITH VOIDS BY THE PULSED NEUTRON TECHNIQUE. **Ocasio-Cabanas, Willie. Raleigh, N. C., North Carolina State Univ., 1968. 131p.**

Thesis.

Decay constants of thermalized neutrons produced by a pulsed 1 MeV Van de Graaff accelerator were measured for different cylindrical systems. These systems consisted of discs stacked to different heights to form homogeneous volumes and combinations of setups with a central void, an annular void, an array of multiple holes, and a heterogeneous system of lucite and aluminum discs. Experimental results for the homogeneous setups were analyzed by a least squares fit of the data to the expressions $\lambda = \lambda_0 + D_0B^2$ and $\lambda = \lambda_0 + D_0B^2 - CB^4$. Systematic analysis of the data showed that, for the range of bucklings measured, the linear fit for which the diffusion cooling coefficient C = 0 resulted in much better agreement than the quadratic fit. Results from the linear fit of the homogeneous cases were used in the analysis of the data obtained with the systems of central voids and annular voids. In each case, theoretical analyses based on diffusion theory were applied. The various theoretical methods were compared with each other and with the experimental data. For the cases of the systems with multiple holes and the setups of lucite and aluminum discs, anisotropic effects were investigated. The experimental data were fitted to the expressions $\lambda = \lambda_0 + D_{0\perp}B_\perp^2 - C_\perp B_\perp^4 + D_{0\parallel}B_\parallel^2 - C_\parallel B_\parallel^4$ and $\lambda = \lambda_0 + D_\perp B_\perp^2 + D_\parallel B_\parallel^2$. Values of the $D_\parallel/D_0$ ratio were obtained which compared favorably with theoretical results found in the literature. Additional experimental measurements were carried out in order to study the effect of void shape on the decay constant. Variation of flux also was studied as a function of position inside the void. Several computer programs were developed and were used in the reduction of the data and in the analysis of the theoretical verifications attempted. (Disser. Abstr.)

13194 MEASURING THE YIELD OF 14.5-MeV NEUTRONS ON A NEUTRON GENERATOR. **Talanin, Yu. N.; Kireev, V. A.; Navalikhin, L. V. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk, Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 59-62(1968). (In Russian).**

The methods selected for measuring the yields of 14.5-MeV neutrons from the $T(d,n)^4He$ reaction were an activation method and a method of determining the neutron flux by measuring the emitted alpha particles by a silicon counter. The activation method depended on a $^{63}Cu(n,2n)^{62}Cu$ reaction (T = 9.8 min; σ = 0.507 barns with a threshold of 10.65 MeV). The activated Cu foil was counted on an end-window beta counter. The absolute value of the induced activity was calculated, and the neutron flux was obtained from the value of this activity. The divergence in results was ~10%. A silicon detector with appropriate discrimination was used to determine the alpha count. The neutron flux was calculated from the alpha flux on the assumption of an isotopic neutron distribution. The agreement between the two methods was within 10%. (TTT)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstract 13211.

13195 APPLICATION OF TRANSLATION-INVARIANT SHELL MODEL TO CALCULATIONS OF THE ENERGY SPECTRA FOR NUCLEI WITH A = 4 AND 5. **Gogsadze, G. Sh.; Kopaleishvili, T. I. (Tbilisi State Univ., USSR). Yadern. Fiz., 875-82(1968). (In Russian).**

Wave functions of the translation-invariant shell model were used as the basis in calculations of the energy levels for nuclei with A = 4 and 5. The energy matrix for an arbitrary nucleus was constructed on this basis. For nuclei with A = 4 all the states with one (odd) and two (even) oscillator excitation quanta were calculated. For nuclei with A = 5 the first excited state $\frac{1}{2}^-$ (T = $\frac{1}{2}$) and all the (even) states with one oscillator excitation quantum were calculated. It is shown in case of nuclei with A = 4 that the state 0^+ (T = 0) is the lowest excited state, the next state with positive parity 2^+ (T = 0) is near to the threshold of the total disintegration of the nucleus. Both results are in agreement with the experimental data. It is shown that such a system has no other bound state with positive parity. The results for the levels with negative parity are also in reasonable agreement with the experiment. In case of nuclei with A = 5, the level $\frac{3}{2}^+$ (T = $\frac{1}{2}$) is the lowest state among the levels with positive parity (in agreement with the experiment). New levels are predicted both with T = $\frac{1}{2}$ and with T = $\frac{3}{2}$. Comparison with present experimental data is fulfilled. The structure of some excited states of nuclei with A = 4 and 5 is discussed. (auth)

13196 THE (π^+,2p) REACTIONS ON NUCLEI. Bressani, T.; Charpak, G.; Favier, J.; Massonnet, L.; Meyerhof, W. E.; Zupancic, C. (CERN, Geneva). pp 87-103 of Symposia on Theoretical Physics and Mathematics. Vol. 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968.

From Symposia on Theoretical Physics and Mathematics, Madras. See CONF-670123.

The results of measurements of excitation-energy and momentum distributions of recoils from (π^+,2p) reactions on several nuclei are presented. The reactions on ^{4}He and ^{6}Li, which were studied in greater detail, are discussed at length. The other target nuclei were ^{27}Al, ^{9}Be, B, ^{40}Ca, ^{12}C, Cl, ^{19}F, Fe, ^{7}Li, ^{14}N, ^{16}O, Pb, and S. The necessity for experiments providing better resolution is noted. (D.C.W.)

13197 ELECTROMAGNETIC FORM FACTORS OF ^{3}H AND ^{3}He. Badalyan, A. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 1128-34(Dec. 1968). (In Russian).

Wave functions for ^{3}H and ^{3}He obtained with the method of K-harmonics for the square-well potential were used to find the electromagnetic form factors of ^{3}H and ^{3}He. Assuming $F_h^n = 0$ the following results were obtained: for the charge radii $r_{ch}(^3H)$ = 1.7 f, $r_{ch}(^3He)$ = 1.8 f; for the magnetic radii $r_{mag}(^3H)$ = 1.71 f, $r_{mag}(^3He)$ = 1.7 f. The values of the radii are in reasonable agreement with the experiment; however, the q^2 dependence of the form factors deviated from the experimental curve at $q^2 = 2$ to 8 f^{-2} systematically by 10 to 20%. With the same accuracy the difference between the charge form factors of ^{3}H and ^{3}He is explained. The reasons for this disagreement are discussed. It is shown that the contribution from the $T = 3/2$ state to the wave function of ^{3}He is negligible. (auth)

13198 NEUTRON–NEUTRON SCATTERING LENGTH FROM A COMPLETE EXPERIMENT ON THE REACTION D(n,2n)H. Zeitnitz, B.; Maschuw, R.; Suhr, P. (Univ., Hamburg). Phys. Lett., 28B: 420-2(Jan. 6, 1969).

The coincident neutron spectra from the reaction D(n,2n)H at E_n = 18.5 MeV ($\theta_1 = 24.2°$, $\theta_2 = 31.2°$) were measured with a double time-of-flight spectrometer. With Watson's final-state interaction theory the results give $a_{nn} = -16.4 \pm 2.9$ fm for the $^1S_0$ n-n scattering length. (auth)

13199 ABSOLUTE DEUTERON-POLARIZATION MEASUREMENT. Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.); Starkovich, V. S.; Simon, W. G.; Bernstein, E. M. Phys. Lett., 28B: 404-5(Jan. 6, 1969).

Data obtained from d-^{4}He double scattering at 11.5 MeV (both scatterings), and over a range of second scattering angles which includes the first scattering angle, are presented. It is shown how this data may be used to provide an absolute calibration for the polarization of a beam of deuterons produced by a polarized-ion source. (auth)

13200 ON THE ANOMALOUS EFFECTIVE RANGE EXPANSION FOR NUCLEON–DEUTERON SCATTERING IN THE S = 1/2 STATE. Reiner, A. S. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett., 28B: 387-90(Jan. 6, 1969).

The effective range expansion for the doublet nucleon-deuteron elastic scattering has a very small radius of convergence due to a pole just below threshold. It is shown in a potential model and by using analyticity arguments that the anomaly (a perturbed Ramsauer–Townsend effect) may be due to the long-range single-nucleon exchange force in the channel of the well-bound triton. (auth)

13201 RELATIONS BETWEEN LOW ENERGY THREE-NUCLEON OBSERVABLES. Phillips, A. C. (Massachusetts Inst. of Tech., Cambridge); Barton, G. Contract AT(30-1)-2098. Phys. Lett., 28B: 378-80(Jan. 6, 1969).

A simple N/D model, in which the chief driving term is a long-range proton exchange interaction, is used to investigate the relation between the triton and low-energy neutron-deuteron scattering parameters. (auth)

13202 PION SCATTERING BY ^{3}He AND ^{3}H. Peterson, Mark A. (Amherst Coll., Mass.); Sternheim, Morton M. Nucl. Phys., A124: 234-40(1969).

Elastic π-^{3}H and π-^{3}He scattering has been suggested as a highly sensitive probe of small nuclear wave function components. More detailed calculations considerably reduce this sensitivity. (auth)

13203 WEAK INTERACTIONS IN THREE-NUCLEON SYSTEMS. Moskalev, A. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 8: 1156-70(Dec. 1968). (In Russian).

Wave functions of tritium and the neutron–deuteron system, and the amplitude for elastic n-D scattering, were obtained in the first order in the nucleon weak interaction. The expressions obtained contain phenomenological constants describing the weak interaction of two nucleons. The calculations were carried out in the framework of the theory of the zero radius of nuclear forces. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 13196, 13265, 13305, 13309, 13330, and 13338.

13204 (EURFNR-591) HIGH RESOLUTION TOTAL NEUTRON CROSS SECTIONS BETWEEN 0.5 TO 30 MeV. Cierjacks, S.; Forti, P.; Kopsch, D.; Kropp, L.; Nebe, J.; Unseld, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). June 1968. 125p. (KFK-1000; EUR-3963; EANDC(E)-111-U). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The results of high-resolution time-of-flight measurements of the neutron total cross sections of C, O, Na, Al, S, Ca, Fe, Tl, and Bi over the energy range from 0.5 to 32 MeV are presented in graphical form. (D.C.W.)

13205 (UCRL-18470) THE (α,d) REACTION ON LIGHT AND MEDIUM MASS NUCLIDES. Lu, Chi Chang (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1968. 134p. Dep. CFSTI.

The (α,d) reactions on targets of ^{13}C, ^{14}C, ^{15}N, and ^{20}Ne were studied using alpha beams of 40.1, 46.0, 45.4, and 44.5 MeV, respectively. Angular distributions were obtained. States with $(1d_{5/2})^2_{J^+,0}$ configuration were located, and possible spin assignments were suggested. These states are: ^{15}N, 13.03 MeV($11/2^-$) and 11.95 MeV($9/2^-$); ^{16}N, 5.75 MeV(5^+); ^{17}O, 7.74 MeV($11/2^-$) and 9.14 MeV($9/2^-$); ^{22}Na, 1.528 MeV 5^+. Separated isotopes of ^{52}Cr, ^{54,56}Fe, ^{59}Co, ^{58,60,62}Ni, ^{63}Cu, and ^{64,66,68}Zn were used as targets to study the (α,d) reaction with a 50-MeV alpha beam. States with a probable configuration of $(1g_{9/2})^2_{J^+,0}$ were located. These states are ^{54}Mn, 9.47 MeV; ^{56}Co, 8.92 MeV; ^{58}Co, 6.79 MeV; ^{60}Cu, 5.99 MeV; ^{62}Cu, 4.75 MeV; ^{64}Cu, 4.57 MeV; ^{66}Ga, 2.99 MeV; ^{68}Ga, 2.88 MeV; and ^{70}Ga, 2.88 MeV. The residual interaction energies between the proton and neutron in the configurations $(1d_{5/2})^2_{J^+,0}$ and $(1f_{7/2})^2_{J^+,0}$, and $(1g_{9/2})^2_{J^+,0}$ were extracted from the excitation energies determined in the present work and previous work on $(1d_{5/2})^2_{J^+,0}$ and $(1f_{7/2})^2_{J^+,0}$ states. For $T_z \neq 0$ nuclides, an "interaction model" method was proposed to extract the residual interaction energy. The mean values of the residual interaction energies are about −3.9, −3.0, and −2.2 MeV, respectively, for the three mentioned configurations. There is a slight decrease of residual interaction energy with increasing A. These results are reproduced excellently by conventional shell model calculations. The results of (α,t) reactions studied simultaneously with the (α,d) reactions are also briefly reported. (auth)

13206 (UCRL–50520) A CALCULATION OF THE ANGULAR AND ENERGY DISTRIBUTIONS FOR NEUTRONS FROM THE ^{9}Be(n,2n) REACTION. Perkins, S. T. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 4, 1968. Contract W-7405-eng-48. 26p. Dep. CFSTI.

The transference functions for the various decay modes of the ^{9}Be(n,2n) reaction were represented by a Legendre expansion up through a P_8. From these results, the differential emission probabilities and the angle-integrated spectra were estimated. (auth)

13207 DISTORTED-WAVE BORN APPROXIMATION ANALYSIS FOR THE REACTION ^{12}C(p,d)^{11}C AT 100 MeV. Li, T. Y.; Mark, S. K. (McGill Univ., Montreal). Can. J. Phys., 47: 257-65(Feb. 1, 1969).

A distorted-wave Born approximation analysis of the ^{12}C(p,d)^{11}C reaction at 100 MeV was performed using the local-energy approximation for the finite-range correction. The neutron was assumed to be picked up from a bound state in a real Saxon–Woods well. The proton potential was fixed, and a search was made to extract the deuteron optical potential parameters by fitting the angular distribution of the ground-state transition. Analysis of the excited states was carried out with all potential parameters fixed. Fairly good agreement with experiment was obtained for the ground state, the 2.0-MeV excited state, and the 4.80-MeV excited state. Transitions to the 4.31-MeV state and states in the 6.9-MeV region were discussed. The spectroscopic factors extracted from experiment were generally smaller than those predicted by Cohen and Kurath, based on the intermediate-coupling shell model. The deuteron optical potential obtained is fairly reasonable with a real well depth slightly deeper than the expected value deduced from the elastic scattering of nucleons. (auth) (CANADA)

13208 NUCLEAR RESONANCE FLUORESCENCE WITH A 4000-Ci ^{60}Co RADIOACTIVE SOURCE. Rust, N. J. A.; Koen, J. W.; Mouton, W. L. (Univ. of Stellenbosch, S. Africa). Nucl. Instrum. Methods, 67: 222-8(Jan. 15, 1969).

Gamma rays of energy continuously variable between 1.332 and 0.25 MeV were obtained by Compton scattering of the gamma radiation from a 4000 Ci ^{60}Co source. Details of the source and its shielding are given, and the energy spread of the scattered beam is discussed. The gamma rays of variable energy were used to observe resonant scattering from ^{7}Li, ^{23}Na, ^{29}Si, and ^{65}Cu. To deduce values for the widths of energy levels, self-absorption measurements as well as measurements of the flux incident on the resonant scatterer were performed. Results, which are much superior to those previously obtained with a weaker source, are presented. (auth)

13209 POLARIZED ELASTIC FAST-NEUTRON SCATTERING OFF ^{12}C IN THE LOWER MeV RANGE. I. EXPERIMENTAL PART. Aspelund, Olav (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Norv., 3: 43-62(1968).

Experimental and theoretical interest in low-energy n + ^{12}C elastic scattering necessitated comprehensive polarization studies between 1.062 and 2.243 MeV. Polarized fast-neutron beams were obtained at $\theta_1 = 50°$ (lab) from the ^{7}Li(p,n)^{7}Be reaction. Seven complete polarization angular distributions were determined from experimental finite-geometry left-right ratios observed at laboratory scattering angles between 30 and 129°. Proper corrections were applied for finite-geometry and polarized multiple-scattering effects, as well as for the presence of the first-excited state group of fast neutrons in the incident beams. The polarization effects are sufficiently large to ensure the potentialities of ^{12}C as an acceptable fast-neutron polarization analyzer in the energy range under consideration. The experimental polarizations were finally used as accessory data in comprehensive phase analyses based upon total and differential scattering cross sections available in current literature. The results of these analyses are in disagreement with less detailed data previously reported by other experimentalists. The energy variations of the phase shifts obtained will be predicted in the theoretical part of this contribution. Corresponding angular distributions of the polarization and the differential scattering cross section do not substantiate a criterion derived for the validity of Rodberg's derivative rule. (auth) (NORWAY)

13210 POLARIZATION OF PROTONS ELASTICALLY SCATTERED ON ^{12}C. Slabospitskii, R. P.; Andreev, G. B.; Lopatko, I. D.; Borovlev, V. I.; Lutsik, V. A.; Taranov, A. Ya. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 8: 865-8(1968). (In Russian).

Measurements of proton polarization from elastic scattering by ^{12}C are given. The work was performed with a beam of polarized protons accelerated in a charge-exchange accelerator. The measurements were made in the energy region 1 to 3 MeV for the scattering angles 45, 60, 90, 120, and 150° in the center-of-mass system. Good agreement of experimental results with theoretical predictions is observed. (auth)

13211 REACTIONS (n,t) ON LIGHT NUCLEI. Rendic, D. (Zagreb Univ.). Bull. Sci., Sect. A, 13: 163(May-June 1968). (In Slavic).

Thesis.

The angular distributions of the ^{3}He(n,t)p, ^{6}Li(n,t)^{4}He, ^{14}N(n,t)^{12}C, and ^{19}F(n,t)^{17}O reactions leading to the ground and some excited states of the residual nuclei were measured. Of 7 angular distributions, 6 were measured at $E_n = 14.4$ MeV and one at 2.7 MeV. The investigation of the ^{3}He(n,t)p reaction represents the study of two-nucleon transfer reactions, and also the few body problem. Owing to this fact the experimental data were analyzed in the framework of El Nadi–Rabi's model for the inverse p + T process. Satisfactory agreement with these theoretical predictions indicates that the heavy particle stripping mechanism plays an important role. The ^{6}Li(n,t)α process was measured at 2.7 and 14.4 MeV. While the process at 14.4 MeV can mainly be explained by a direct pickup mechanism, the same reaction at 2.7 MeV indicates the complexity of the reaction mechanism. The (n,t) reactions on ^{14}N and ^{19}F (transitions to the ground state and first excited state of ^{12}C and ^{17}O) were analyzed in the framework of the simple Butler and Newns PW theories. The observed shapes of the measured angular distributions indicate that the processes proceed through a direct pickup mechanism. (auth)

13212 ELASTIC SCATTERING OF LITHIUM NUCLEI. Bethge, K.; Fou, C. M.; Zurmuehle, R. W. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., A123: 521-30(1969).

The elastic scattering of ^{6}Li and ^{7}Li nuclei on ^{13}C, ^{16}O, ^{19}F, ^{24}Mg, ^{29}Si, and ^{40}Ca was measured at $E_{lab} = 20$ MeV. The measured angular distributions were compared with optical-model calculations. The best fit optical-model parameters are presented. (auth)

13213 TRANSFER REACTION BY THE BOMBARDMENT OF ^{10}B WITH ^{16}O AND ^{14}N. Ischenko, G.; Voit, H.; Blatt, E.; Helb, H.-D.; Krubasik, E. (Univ., Erlangen, Ger.). Nucl. Phys., A123: 497-512(1969). (In German).

Differential cross sections for the deuteron and alpha transfer of the reaction ^{10}B(^{16}O,^{14}N)^{12}C and the deuteron transfer of the reaction ^{10}B(^{14}N,^{12}C)^{12}C were measured at the Erlangen tandem Van de Graaff accelerator in the energy range from 22.5 to 32.5 MeV (lab). The production of negative ions, the preparation of self-supporting boron targets, and the methods of detection and analysis with an on-line computer are described. The angular distributions partially show regular oscillations, which can be interpreted within the framework of the diffraction model of Dar. (auth)

13214 ELASTIC FORM FACTOR OF THE ^{6}Li NUCLEUS USING IMPROVED RADIAL WAVE FUNCTIONS. Radhakant, S.; Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., A123: 673-80(1969).

A variational calculation is performed for the ground state of the ^{6}Li nucleus using trial radial wave functions, which are linear combinations of the harmonic oscillator and the exponential type. Two sets of variational parameters are obtained using Volkov and Brink interactions. The elastic charge form factor of the ^{6}Li nucleus with the Brink interaction is found to be in good agreement with the experimental result and the result obtained by Bouten et al. using the projected Hartree–Fock technique. It is shown that the charge density obtained with the improved radial wave function is in agreement with the charge density given by the phenomenological model of Hofstadter. (auth)

13215 PHOTONUCLEAR REACTIONS IN ^{40}Ca AND ^{16}O LEADING TO EXCITED STATES OF THE RESIDUAL NUCLEI. Ullrich, H.; Krauth, H. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Phys., A123: 641-8 (1969).

De-excitation γ rays following the photodisintegration of ^{40}Ca and ^{16}O in the giant resonance region were observed with a Ge–Li detector. Approximate values of integrated cross sections for various (γ,p) and (γ,n) reactions leading to excited states are given. (auth)

13216 ANGULAR CORRELATION STUDY OF THE REACTIONS ^{12}C(^{3}He,^{3}He$'_1\gamma_{4.43}$)^{12}C AND ^{12}C($\alpha,\alpha'_1\gamma_{4.43}$)^{12}C. Assousa, George Elias. Tallahassee, Fla., Univ. of Florida. 1968. 217p.

Thesis.

Particle-gamma angular correlations were measured for the reaction ^{12}C(^{3}He,^{3}He$'_1\gamma_{4.43}$)^{12}C at 17.0 MeV and the reaction ^{12}C($\alpha,\alpha'_1\gamma_{4.43}$)^{12}C at 19.0 MeV. Forty-three ^{3}He$'_1-\gamma$ reaction-plane correlations were obtained for laboratory scattering angles between 13.5° and 170°. The 90°-to-reaction-plane ^{3}He$'_1-\gamma$ correlations were measured for twenty angles between 19 and 114° and the spin-flip probability was extracted. The ^{3}He$'_1-\gamma$ reaction-plane correlations were analyzed using a limited partial wave treatment. The $\alpha'_1-\gamma$ angular correlations were measured for fifty-five laboratory scattering angles between 9° and 171°. The observed behavior of these correlations was similar to that seen for $\alpha'_1-\gamma$ data at higher energies. A limited partial wave treatment was also carried out. Possible exchange effects for both the ^{3}He and α data were considered. Both in-plane and 90°-to-reaction-plane ^{3}He$'_1-\gamma$ correlations were analyzed simultaneously with available ^{3}He elastic (0^+) and inelastic (2^+, 4.43 MeV) scattering data from ^{12}C. The coupled-channel calculations were performed for an oblate rotator model of ^{12}C using the adiabatic approximation, and also the non-adiabatic 0^+-2^+ treatments. Fair agreement between the coupled-channel calculations and the ^{3}He experimental data was obtained. (Disser. Abstr.)

13217 INVERTED COEXISTENCE OF SPHERICAL AND DEFORMED STATES IN LIGHT NUCLEI. Bar-Touv, J.; Goswami, A. (Case Western Reserve Univ., Cleveland). Phys. Lett., 28B: 391-4(Jan. 6, 1969).

The possibility of "inverted" coexistence of spherical and deformed states in ^{28}Si, ^{32}S, and ^{12}C is explored. (auth)

13218 FINAL STATE COULOMB INTERACTION STUDIES WITH THE ^{6}Li(^{6}Li,α)^{8}Be REACTION. Ingram, F. Duane Iowa City, Ia., Univ. of Iowa, 1968. 82p.

Thesis.

It was postulated that the long-range final-state Coulomb interaction should be important in reactions going to three partial final states when the outgoing particles are charged. An experiment studying the sequential decay of the ^{6}Li(^{6}Li,α)^{8}Be reaction was performed to look for evidences of these final-state effects. The main features of the experimental energy spectrum were fitted with a classical calculation. (Disser. Abstr.)

13219 DIFFERENTIAL CROSS SECTIONS FOR ^{14}N(α,p$_1$)^{17}O. Rose, Frederick Anton Madison, Wis., Univ. of Wisconsin, 1968. 96p.

Thesis.

A description is given of a He$^-$ ion source which was built for use with a Van de Graaff tandem accelerator. The source uses the principle of a charge exchange in cesium vapor suggested by Donnally and produces a current of one to two microamperes, most of which could be transmitted through the tandem to give analyzed currents of a few microamperes of high energy He^{2+}. The alpha beam was used to study the reaction ^{14}N(α,p$_1$)^{17}O*. Differential cross sections for all proton groups up to E$_x$(^{17}O) ≤ 6 MeV were measured at various laboratory angles from 14 to 166° and at alpha energies of 12.99 and 13.39 Mev. Angular distributions were also obtained for all proton groups up to E$_x$(^{17}O) ≤ 7.6 MeV for alpha energies of 14.25, 14.5, and 18.07 MeV. In addition, some data were obtained at 16.03 MeV. An E-dE/dx solid state counter telescope was used in a differentially pumped gas scattering chamber. Experimental proton energy resolution was about 100 keV. The center-of-mass cross sections obtained have a relative accuracy of about 1.5% and an absolute accuracy of about 3.5%. No indication was found of a state near 6.24-MeV excitation in ^{17}O as reported by Burrows. At the higher bombarding energies the previously unconfirmed state at 7.0 MeV was clearly present and the broad state at 6.37 MeV reported by Bockelman was also observed. The broad state at 7.28 MeV was not seen. The state at E$_x$(^{17}O) = 5.22 MeV which has a small cross section in the ^{16}O(d,p)^{17}O reaction and has never been seen in the ^{16}O(n,n)^{16}O reaction, has generally the largest cross section of any ^{17}O state seen in the present study. Only at the highest bombarding energy is there a suggestion of any direct reaction contributions. In fact, many of the angular distributions have approximate symmetry about θ_{cm} = 90°. A statistical model of the compound nucleus may therefore be appropriate. When the integrated cross section of each proton group was plotted versus (2J + 1) (where J is the known spin of the relevent ^{17}O state), a reasonable proportionality is found except for states with J = $^3/_2$. Such states have anomalously low cross sections. The E$_x$(^{17}O) = 5.22 MeV state has unknown spin and parity. Its integrated cross section, if also proportional to (2J + 1), would require J = $^9/_2$ ± 1. (Disser. Abstr.)

13220 LIFETIME MEASUREMENTS IN THE P AND S-D SHELLS BY THE DOPPLER SHIFT ATTENUATION METHOD. Throop, Medville Jay. Iowa City, Ia., Univ. of Iowa, 1968. 286p.

Thesis.

The Doppler shift attenuation method was used to deduce lifetime information for electromagnetic transitions in ^{10}B, ^{11}B, ^{12}B, ^{13}B, ^{11}C, ^{12}C, ^{14}C, ^{14}N, ^{15}N, ^{16}N, ^{17}N, ^{16}O, ^{18}O, ^{18}F, ^{20}Ne, ^{21}Ne, ^{22}Ne, ^{22}Na. The combination of a Ge(Li) gamma-ray detector and the use of lithium-induced reactions permitted an accurate measurement of numerous lifetimes as well as the setting of improved limits for very fast lifetimes. In addition, a number of transition energies were measured with much improved accuracy. (Diss. Abstr.)

13221 A STUDY OF LOW-LYING T = $^3/_2$ AND T = 2 STATES IN SOME LIGHT NUCLEI. I. Adelberger, E. G.; McDonald, A. B.; Barnes, C. A. (California Inst. of Tech., Pasadena). Nucl. Phys., A124: 49-84(1969).

Double-stripping (^{3}He,n) reactions were used to locate low-lying T = $^3/_2$ and T = 2 states in several light nuclei. Accurate values for the excitation energies of these states were obtained using a high-resolution time-of-flight spectrometer. The identifications are based upon the intensities of transitions, upper limits on level widths and spin and parity assignments inferred from the shapes of angular distributions. Isospin $^3/_2$ levels in ^{13}N were located at excitation energies of 15.068 ± 0.008 MeV (Γ < 15 keV), 18.44 ± 0.04 MeV and 18.98 ± 0.02 MeV (Γ = 40 ± 20 keV) in a study of the ^{11}B(^{3}He,n) reaction at incident energies up to 13.5 MeV. Isospin $^3/_2$ levels in ^{17}F were observed at excitation energies of 11.195 ± 0.007 MeV (Γ < 20 keV), 12.540 ± 0.010 MeV (Γ < 25 keV) and 13.059 ± 0.009 MeV (Γ < 25 keV) in a study of the ^{15}N(^{3}He,n) reaction at incident energies up to 11.9 MeV. Isospin $^3/_2$ levels in ^{21}Na were observed at excitation energies of 8.99 ± 0.05 MeV and 9.221 ± 0.015 MeV (Γ < 40 keV) in a study of the ^{19}F(^{3}He,n) reaction at incident energies up to 10.0 MeV. The excitation energy of the lowest T = 2 state in ^{20}Ne was measured to be 16.730 ± 0.006 MeV (Γ < 20 keV) in a study of the ^{18}O(^{3}He,n) reaction at incident energies up to 9.0 MeV. The excitation energy of the lowest T = 2 state in ^{24}Mg was measured to be 15.441 ± 0.015 MeV (Γ < 35 keV) in a study of the ^{22}Ne(^{3}He,n) reaction at incident energies up to 9.5 MeV. (auth)

13222 IS THE STRUCTURE OF ^{16}O UNDERSTOOD? Krieger, S. J. (Univ. of Illinois, Chicago). Phys. Rev. Lett., 22: 97-9 (Jan. 20, 1969).

It is argued that the structure of ^{16}O can not be completely understood unless the position of the first O$^+$ state can be calculated without using adjustable parameters. It is further demonstrated that this state can not be calculated by Hartree-Fock or related methods using the present generation of nuclear forces. (auth)

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Refer also to abstracts 12974, 13196, 13204, 13205, 13208, 13212, 13215, 13217, 13220, 13221, 13264, 13265, 13277, 13305, and 13336.

13223 (AI-AEC-12741) EVALUATED NEUTRON CROSS SECTIONS FOR ^{63}Cu, ^{65}Cu, AND NATURAL COPPER. Otter, J. M.; Hubner, R. S.; Campbell, R. W.; Dunford, C. L.; Alter, H. (Atomics International, Canoga Park, Calif.). Dec. 15, 1968. Contract AT(04-3)-701. 125p. (ENDF-124). Dep. CFSTI.

Evaluated neutron cross-section data for ^{63}Cu, ^{65}Cu, and naturally occurring Cu have been prepared for the ENDF/B nuclear data file. Calculations, based on nuclear systematics, were used to augment available experiment data, where required. A complete set of neutron cross-section data was prepared for each nuclide, for incident neutron energies between 10^{-3} and 1.5×10^7 eV. These data, in ENDF/B format, have been forwarded to the National Neutron Cross Section Center, at Brookhaven National Laboratory, for distribution. (auth)

13224 (ANU-P-418) LEVEL WIDTHS IN THE COMPOUND NUCLEUS ^{32}S FROM THE REACTION ^{31}P(p,p$_0$). Hellstroem, J.; Dallimore, P. J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1967]. 23p. Dep.

The mean level width in the compound nucleus ^{32}S at an excitation energy of between 16.61 and 18.55 MeV was investigated by the reaction ^{31}P(p,p$_0$). Excitation functions were measured in 10-keV steps from 8.00 to 10.00 MeV and at 15 angles between 30 and 160° (lab). The excitation functions were analyzed by the Fourier analysis method, and there is evidence for a dependence of the mean level width on angle. The statistical model is unable to predict this angular dependence although it does predict the observed energy dependence of the mean level width. (auth)

13225 (ANU-P-419) GAMMA-RAY BRANCHING RATIOS OF THE LOW-LYING LEVELS OF ^{28}Al. Kean, D. C.; Carter, K. W.; Spear, R. H. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 14p. Dep.

A 12.7 cm × 10.2 cm NaI(Tl) γ spectrometer was used in conjunction with a 61-cm magnetic particle spectrometer to measure γ branching ratios for levels in ^{28}Al at excitation energies of 1.76, 2.23, 2.87, 3.07, 3.19, 3.44, and 3.58 MeV. (auth)

13226 (CEA-R-3609) STUDY OF THE NEUTRON STRENGTH FUNCTION AND OF THE SCATTERING RADIUS AS A FUNCTION OF MASS NUMBER. Morgenstern, Joseph (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 207p. (In French). Dep.

Thesis.

The strength functions S$_0$ and S$_1$ and the scattering length R′ were studied. The values of S$_0$, S$_1$, and R′ were obtained by shape analysis of the individual resonances observed in total neutron cross-section measurements. These measurements were performed by the time-of-flight method. The best resolution achieved was equal to 0.19 ns/m. The nuclei around number of mass A = 50, 90, 140, and 200 were studied in particular. The experimental values of S$_0$, S$_1$, and R′ were compared with optical model calculations. Fairly good agreement was obtained using an optical potential with surface absorption. (auth)

13227 (UCRL-71093) ELECTRON CAPTURE AND POSITRON DECAY OF ^{57}Ni TO LEVELS OF ^{57}Co. Gatrousis, C.; Meyer, R. A.; Mann, L. G. (California Univ., Livermore. Lawrence Radiation Lab.). June 25, 1968. 6p. (CONF-680703-3). Dep. CFSTI.

From International Conference on Electron Capture and Higher Order Processes in Nuclear Decay, Debrecen, Hungary.

The decay of 36.0-hr ^{57}Ni produced by the ^{54}Fe(α,n)^{57}Ni reaction was studied to obtain information on the level structure of ^{57}Co. Gamma spectra were obtained with high-resolution Ge(Li) detectors, a Compton suppressed Ge(Li) system, and Ge(Li)-

NaI(Tl) $\gamma-\gamma$ coincidence spectroscopy. The γ-ray energies in keV (and the relative photon intensities) observed in this investigation are as follows: 127.1 ± 0.1(200), 161.8 ± 0.3(0.22), 252.5 ± 0.6(≤0.4), 380.0 ± 0.2(0.96), 673.4 ± 0.2(0.58), 906.8 ± 0.3(1.1), 1046.4 ± 0.2(1.6), 1223.5 ± 0.4(1.1), 1377.6 ± 0.2(1000), 1730.6 ± 0.3(0.72), 1757.6 ± 0.2(77), 1896.5 ± 0.4(0.28), 1919.5 ± 0.2(170), 2132.9 ± 0.3(0.47), 2730.6 ± 0.2(0.3), 2803.9 ± 0.2(1.7), 3176.9 ± 0.3(0.24). On the basis of Ge(Li)-NaI(Tl) coincidence experiments, energy sums, and earlier nuclear reaction data, levels in ^{57}Co were assigned at 0($7/2^-$), 1223.5 ± 0.4 ($9/2^-$), 1377.6 ± 0.2($3/2^-$), 1504.7 ± 0.2($1/2^-$), 1757.6 ± 0.2($3/2^-$), 1896.5 ± 0.4($7/2^-$), 1919.5 ± 0.2($5/2^-$), 2132.9 ± 0.3($5/2^-$), 2730.6 ± 0.2($5/2^-$,$3/2^-$), 2803.9 ± 0.2($3/2^-$,$5/2^-$),3108.2(≤$5/2^-$), and 3176.9 ± 0.3($5/2^-$) keV. The spin assignments are based on data from nuclear reaction studies, log-ft values and relative gamma intensities. An attempt was made to explain the experimental results and the structure of ^{57}Co in terms of single-particle states and particle-plus-core states based on coupling the 2^+ collective core vibration to the $f_{7/2}$ odd proton. Previous work on ^{57}Co and ^{59}Co indicates that levels in ^{57}Co at 1223.5($9/2^-$), 1683($11/2^-$), 1757.6($3/2^-$) and 2132.5($5/2^-$) keV belong to a core-coupled multiplet. The gamma-ray branching ratios are in agreement with this characterization of the states at 1223.5 and 1757.6 keV. (auth)

13228 LEVELS OF ^{33}Cl STUDIED BY PROTON CAPTURE IN ^{32}S. Lie, A. S.; Loensjoe, O. (Univ. of Oslo). Phys. Norv., 3: 1-8(1968).

The yield of gamma rays was studied in the proton energy range from 1750 to 2300 keV. One new resonance was found at E_p = 2229 keV (E_x = 4.45 MeV). The resonance energies and half-widths of the resonances at 1755 keV, 1893 keV, and 2229 keV were measured with fairly high accuracy. The widths of all these resonances are smaller than the proton beam energy spread. The resonance at 1893 keV was shown to be different from the resonance at 1900 keV found in elastic proton scattering. The energy of a level near 2 MeV was determined to be 2.00 ± 0.02 MeV, and it was shown to decay predominantly to the ground state. This level probably has spin and parity $5/2^+$ while the level at 3.99 MeV is probably $3/2^+$. The level at 4.12 MeV has spin 3/2 and probably positive parity. The absolute strengths of the primary gamma-ray transitions from the resonances at 1755 keV and 1893 keV are given. (auth) (NORWAY)

13229 POLARIZATION MEASUREMENTS ON GAMMA RAYS FROM TRANSITIONS IN ^{32}S. Doerum, O. (Univ. of Oslo). Phys. Norv., 3: 31-41(1968).

The linear polarization of the 1.61-, 2.24-, 2.77-, and 3.61-MeV transitions in the $^{31}P(p,\gamma)^{32}S$ reaction at 1436-keV proton energy was measured with a Compton polarimeter. From this measurement the spin and parity of three levels in ^{32}S were deduced. The 6.62- and 5.01-MeV states are the lowest-lying odd-parity states so far found in ^{32}S. (auth) (Norway)

13230 PARTICLE-HOLE CONFIGURATIONS OF NUCLEI ^{60}Ni, ^{64} ^{66}Zn. Okorokov, V. V.; Serezhin, V. M.; Smotryaev, V. A.; Tolchenkov, D. L.; Trostin, I. S.; Cheblukov, Yu. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 869-74(1968). (In Russian).

Highly excited states of the nuclei ^{60}Ni, ^{64,66}Zn were investigated in the (d,n) reactions. The particle-hole configurations were ascribed to these states. Cross sections of the (d,n) reactions were calculated in the distorted-wave approximation. (auth)

13231 STUDYING THE REACTION $^{27}Al(p,\alpha)^{24}Mg$ IN THE REGION OF PROTON ENERGIES 2.3 TO 3.4 MeV. Strashinskii, A. G.; Skakun, N. A.; Khomyakov, G. K. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz., Zh., 13: 1839-42(1968). (In Russian).

The nuclear reaction $^{27}Al(p,\alpha)^{24}Mg$ was investigated in the region of proton energies from 2.3 to 3.4 MeV. Semiconductor detectors of n-silicon with resistivity 90 and 300 Ω · cm were used. The energy resolution of the whole system (detector—electronics) was 1.2%. A free aluminium target was used with a thickness of 10 μg/cm². The measurements were carried out with a 4-keV step between resonances and 1 keV in the resonance region. The excitation function was measured for two groups of α particles. Thirty-two resonances of the α_0 group and 20 resonances of the α_1 group were found. Excitation energies of an intermediate nucleus of ^{28}Si are presented which correspond to the detected resonances. Angular distributions of both α-particle groups were measured in the peaks of the isolated resonances. Most of the angular distributions measured proved to be nonsymmetric with respect to an angle of 90° in the center-of-mass system. (auth)

13232 SMALL ANGLE ELASTIC SCATTERING OF 4 MeV NEUTRONS BY NUCLEI Cu, In, Sn, Pb, Bi, AND U. Gorlov, G. V.; Lebedeva, N. S.; Morozov, V. M. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 8: 1086-95(Dec. 1968). (In Russian).

Elastic scattering of polarized neutrons with E_n = 4 MeV by the nuclei Cu, In; Sn, Pb, Bi, and U was studied in the angle interval 2 to 21°. It was found that the properties of the observed differential cross sections and the polarizing powers of the nuclei studied are reasonably described assuming only nuclear and the Coulomb (according to Schwinger) neutron scattering. Polarizing powers of nuclei, differential cross sections of the elastic scattering of unpolarized neutrons, differential cross sections of the forward nuclear elastic scattering $\sigma(0°)$ as well as the forward nuclear scattering amplitude up to the sign of the phase, i.e., $\mathrm{Im}f_n(0°)$ and $|\mathrm{Re}f_n(0°)|$, were determined from the experimental values of the differential and total cross sections. The neutron polarization was measured from the (d,d) reaction at E_d = 1.2 MeV and $\alpha_{l.s.}$ = 37°: $P_d = -14.5 \pm 1.5\%$. (auth)

13233 SPECTROSCOPIC FACTORS OF 2p TRANSITIONS IN THE REACTION (d,p) ON NUCLEI OF MEAN ATOMIC WEIGHT. Gridnev, K. A.; Zherebtsova, K. I.; Komarov, V. A.; Krasnov, L. V.; Litvin, V. F.; Nemilov, Yu. A. (Leningrad State Univ.). Yadern. Fiz., 8: 1101-11(Dec. 1968). (In Russian).

The data on the reaction (d,p) on the isotopes ^{50,52,54}Cr, ^{54,56,58}Fe, ^{58,60,62,64}Ni, and ^{64,66,68,70}Zn for transitions to 2p levels were treated by the distorted-wave method. Spectroscopic factors were determined. Occupation numbers for 2p levels were obtained. These numbers were compared with the values calculated according to the pair correlation model. (auth)

13234 THE $^{45}Sc(n,p)^{45}Ca$ AND $^{45}Sc(n,\alpha)^{42}K$ MEAN FISSION NEUTRON CROSS SECTIONS. De Regge, P.; Dams, R.; Hoste, J. (Ghent Univ.). Radiochim. Acta, 10: 156-9(Dec. 1968).

The mean fission neutron cross sections of the reactions $^{45}Sc(n,p)^{45}Ca$ and $^{45}Sc(n,\alpha)^{42}K$ were determined experimentally from the absolute ^{45}Ca and ^{42}K activities induced in irradiated scandium trioxide. For this purpose a quantitative separation method for calcium and potassium from scandium was developed using a cation exchanger. The absolute calcium activity was measured by liquid scintillation and 4π beta counting, whereas the potassium activity was measured with a calibrated Geiger-Mueller tube and by gamma spectrometry. For the cross sections of the reactions $^{45}Sc(n,p)^{45}Ca$ and $^{45}Sc(n,\alpha)^{42}K$, respective values of 34.6 ± 0.5 mbarn and 0.158 ± 0.004 mbarn where obtained. (auth)

13235 ELASTIC SCATTERING OF POLARIZED 1.5 MeV NEUTRONS BY Mg, Al, AND Si NUCLEI. Korzh, I. A.; Mishchenko, V. A.; Pasechnik, M. V.; Pravdivyi, N. M.; Sanzhur, I. E.; Totskii, I. A. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 1781-7(1968). (In Russian).

Elastic scattering of polarized 1.5-MeV neutrons by Mg, Al, and Si nuclei in the scattering angle range 20 to 143° was studied. By the measured differential cross sections of polarized neutron elastic scattering, the differential cross sections of nonpolarized neutron elastic scattering were determined as functions of the scattering angle. The possibility of describing experimental data on polarized neutron scattering in terms of an optical model of the nucleus was investigated. (auth)

13236 NUCLEON ESCAPE WIDTHS OF THE GIANT DIPOLE RESONANCES IN SPHERICAL NUCLEI. Ligensa, Rainer; Greiner, Walter (Univ. of Virginia, Charlottesville. Univ., Frankfurt am Main). Ann. Phys. (N. Y.), 51: 28-67(Jan. 1969).

The proton and neutron escape widths for the various giant resonances in ^{54}Mn, ^{56}Fe, ^{60}Ni, ^{72}Ge, ^{74}As, ^{90}Zr, and ^{106}Ag were calculated. The giant resonances are described in the Dynamic Collective Model (DCM) where giant resonance phonons are coupled with surface quadrupole vibrations. The initial states are given by the collective wave functions of the DCM while the final states are particle-hole states which are coupled to surface phonons. Up to two surface phonons were considered in the final states. The particle wave functions were computed in a Saxon—Woods potential obtained from low-energy neutron scattering. All partial widths for protons and neutrons are represented in tables. The total widths are represented together with the dipole strengths for the various giant dipole resonances in figures. Typical total widths are varying between 0.5 and 1.5 MeV. In general the total escape widths for those giant resonances which are at higher energies are larger than for those at lower energies. Formulas for the angular distributions of the escaping nucleons in terms of the various partial widths are furnished. (auth)

13237 γ-RAY ABSORPTION CROSS SECTION FOR SULPHUR NUCLEI IN GIANT DIPOLE RESONANCE REGION. Dolbilkin, B. S.; Isakov, A. I.; Korin, V. I.; Lazareva, L. E.; Nikolaev, F. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 8: 1080-5 (Dec. 1968). (In Russian).

The γ-ray absorption cross section for sulphur nuclei was measured in the energy interval 10 to 30 MeV by means of absorption techniques. A magnetic pair spectrometer with nearly 1% resolution was used. The cross section has a distinct resonance structure. A comparison with the data of other experiments as well as with theoretical results is presented. The integral γ-ray absorption cross section in the indicated energy interval is 420 ± 50 MeV · mbarn. The integral (γ,p) reaction cross section (200 ± 70 MeV · mbarn in the energy region 15 to 30 MeV) and the ratio of the integral (γ,p) and (γ,n) reaction cross sections were estimated using the integral absorption cross section and the (γ,n) reaction cross section. (auth)

13238 DECAY OF ISOMERS OF ^{62}Co. Kiselev, B. G.; Levkovskii, V. N.; Kazachevskii, I. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 8: 1063-6(Dec. 1968). (In Russian).

Beta and γ spectra of 14- and 1.5 min isomers of ^{62}Co were studied. Energies (in keV) and relative intensities of γ rays of the 14-min isomer were found to be 1163.5(75); 1172.3(100); 1709.2(7.2); 2003.1(15), and 2104.0(7.3). The end point energy of the β spectrum is 2900 ± 100 keV. The 1.5-min isomer was found to have the γ lines 1128(19.5), 1172.3(100), 1980(3), 2300(19), and 3150(2). The end point energy of the β spectrum was found to be 4300 ± 100 keV. The decay modes of both the isomers are presented. (auth)

13239 RESONANCE PARAMETERS AND S_0 AND S_1 STRENGTH FUNCTIONS FOR Cl, ^{51}V, ^{89}Y, Zr, La, ^{141}Pr, AND ^{209}Bi. Morgenstern, J.; Alves, R. N.; Julien, J.; Samour, C. (CEN, Saclay, France). Nucl. Phys., A123: 561-80(1969). (In French).

The total neutron cross sections of Cl, ^{51}V, ^{89}Y, Zr, La, ^{141}Pr, and ^{209}Bi were measured. Experimental data were fitted with a multi-level formula to obtain the individual resonance parameters. Values of the strength functions S_0 and S_1 and of the scattering lengths R′ were obtained and were compared with optical-model calculations. (auth)

13240 THE ^{54}Cr(^{3}He,d)^{55}Mn REACTION. Rapaport, J.; Belote, T. A.; Dorenbusch, W. E.; Doering, R. R. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A123: 627-40(1969).

The proton states in ^{55}Mn were studied by means of the ^{54}Cr(^{3}He,d) reaction with 10.0-MeV ^{3}He ions. Deuteron angular distributions for stripping transitions to states below 5.5-MeV excitation were measured using the MIT multiple-angle spectrograph. A DWBA analysis was carried out to determine l_p values and transition strengths. The observed level structure of ^{55}Mn is compared with those from (^{3}He,d) reactions leading to ^{53}Mn and ^{51}Mn. (auth)

13241 PROTON SCATTERING ON ^{22}Ne. Hulubei, H.; Neamu, I.; Vladuca, G.; Scintei, N.; Martalogu, N.; Teodorescu, C. M.; Ivascu, M.; Berinde, A. (Inst. for Atomic Physics, Bucharest). Nucl. Phys., A123: 531-40(1969).

Differential cross sections for the p_0, p_1, and p_2 groups from the reaction ^{22}Ne(p,p′) were measured at 12 energies in the range E_p = 4.82 to 8.20 MeV and at E_p = 14.00 MeV. The p_0 and p_1 angular distributions averaged over the range E_p = 4.82 to 6.20 MeV were analyzed with the optical model, the statistical model and the DWBA. The p_0 angular distribution at E_p = 14 MeV is in good agreement with the optical-model calculations. Excitation functions in the range E_p = 3.6 to 6.2 MeV show strong fluctuations. A strong resonance in the (p,p_2) excitation function at E_p = 5.73 MeV corresponds to ^{23}Na(14.27 MeV), i.e. the isobaric analogue state of ^{23}Ne(≈6.50 MeV). The angular distribution at this resonance was analyzed in terms of the single-resonance theory. (auth)

13242 REACTION MECHANISM OF ^{32}S(d,pα)^{28}Si GROUND STATE REACTION AT E_d = 12.0 AND 17.0 MeV. Burke, J. A.; Saladin, J. X.; Rollefson, A. A. (Univ. of Pittsburgh). Nucl. Phys., A123: 546-60(1969).

The ^{32}S(d,pα)^{28}Si g.s. reaction was studied at bombarding energies of 12.0 and 17.0 MeV. Coincident protons and alpha particles were detected using solid-state detectors, and their correlated energy spectra were analyzed by a 64 × 64 channel pulse-height analyzer. Measurements were carried out at various angular combinations (θ_p,θ_α). The angular dependence of the differential cross section and the shapes of the energy spectra were compared with the results of some simple model calculations. It was found that at a bombarding energy of 12.0 MeV, the reaction proceeds mainly by a double evaporation process, although for small proton angles a significant contribution of a direct (d,p) reaction followed by an alpha evaporation is visible. At a bombarding energy of 17.0 MeV, the reaction mechanism is predominantly the latter direct-evaporation process. (auth)

13243 QUADRUPOLE MOMENT OF ^{57m}Fe. Chappert, J. (Massachusetts Inst. of Tech., Cambridge); Frankel, R. B.; Misetich, A.; Blum, N. A. Phys. Lett., 28B: 406-7(Jan. 6, 1969).

The quadrupole splitting induced by a magnetic field at low temperatures was measured by Moessbauer spectroscopy for Fe^{2+} in MgO; a value of +0.21 ± 0.03 barn for the quadrupole moment of ^{57m}Fe was obtained. (auth)

13244 LARGE-ANGLE SCATTERING OF ^{3}He PARTICLES BY ^{58}Ni. Kamitsubo, H.; Wada, T.; Fujisawa, T.; Igarashi, M. (Inst. of Physical and Chemical Research, Saitama, Japan). Phys. Lett., 28B: 408-10(Jan. 6, 1969).

The large-angle scattering of ^{3}He particles by ^{58}Ni was measured to obtain better optical parameters and to estimate the strength of the spin-orbit interaction, which yielded V_{ls} = 4.7 ± 1.0 MeV. (auth)

13245 MUON PARTIAL CAPTURE RATES IN LIGHT SPIN ZERO NUCLEI USING Ge-Li DETECTOR. Pratt, Theodore A. E. C. Pittsburgh, Carnegie-Mellon Univ., 1968. 133p. Thesis.

The mechanism of muon capture in complex nuclei could be understood by studying, what daughter nuclei are formed and in what amounts, after muon capture in the ground state of the target nucleus. Gamma spectra resulting in de-excitation of the excited levels of daughter nuclei following muon capture in naturally occurring Mg, Si, S, and Ca are presented. These spectra were obtained using a 3.5-cc and a 15.3-cc Ge(Li) detector separately. The whole γ-ray detection system was calibrated for energy and efficiency. The energy calibration was done using radioactive sources—^{56}Co, ^{24}Na, and ^{137}Cs. Muonic K x rays from targets having a wide range of "Z"—proton-content were used in the efficiency calibration of the γ-ray detector system. Partial capture rates based on the efficiency calibration per muon stop are reported for excited states of daughter nuclei following muon capture in Si, S, and Ca. No partial capture rates are reported for the Mg capture gammas though the Mg capture spectrum is qualitatively discussed. The predominant belief, that the dominant process after muon capture is the single neutron emission mode, is supported. However, there seems to be a relatively high percentage of capture rate resulting in the emission of a neutron and a proton together compared to other modes except that of neutron emission only. This is especially seen in the Ca and Si spectra. This observation may be used in understanding single-particle energy spectra obtained in muon capture experiments. (Disser. Abstr.)

13246 HIGH RESOLUTION INELASTIC PROTON SCATTERING NEAR A = 50. Kyker, G. C. Jr.; Bilpuch, E. G.; Newson, H. W. (Duke Univ., Durham, N. C.). Ann. Phys. (N. Y.), 51: 124-61(Jan. 1969).

The yield of the deexcitation gamma ray following inelastic proton scattering to the first excited states of ^{46}Ti, ^{48}Ti, ^{50}Cr, ^{54}Fe, and ^{56}Fe was studied for proton energies between 2.5 and 3 MeV with energy resolution of approximately 1700 eV. For all targets except ^{54}Fe, angular distributions of the gamma-ray yield were measured as a means of assigning spins and parities to resonances observed in the excitation functions. A total of approximately 160 resonances were observed and assigned in this way. This work has shown the first excited state of ^{50}Cr to have spin 2. In addition, the spacings of $5/2^+$ levels in the compound nuclei ^{47}V, ^{51}Mn, and ^{57}Co are consistent with the dependences on neutron excess and shell structure observed in neutron total cross section measurements. There are also indications in the data of a maximum in the D-wave proton strength function in the neighborhood of mass number 47. (auth)

13247 DECAY OF 56-MIN ^{69g}Zn, 14-HR ^{69m}Zn, AND 39-HR ^{69}Ge TO LEVELS OF ^{69}Ga. Zoller, W. H.; Gordon, G. E.; Walters, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)905. Nucl. Phys., A124: 15-33(1969).

The decay of ^{69m}Zn was found to have weak β branches to the 574- (0.032 ± 0.005%) and 872-keV (0.04 ± 0.002%) levels of ^{69}Ga in addition to the prominent (<99.9%) 439-keV isomeric transition to ^{69g}Zn. Decay of the latter includes a weak (0.0015 ± 0.0005%) β branch to the 318-keV level of ^{69}Ga. Ten of the 36 γ rays assigned to the decay of ^{69}Ge in this work had not previously been observed. Levels were established in ^{69}Ga at 318, 574, 872, 1106, 1336, 1487, 1525, 1723, 1891, 1923, 2022, and 2043 keV. The recent level predictions by Kisslinger and Kumar are in better agreement with the observed levels of ^{69}Ga than previous calculations although discrepancies in levels positions are still rather large. As the energies of the excited states of even nuclei in the vicinity of ^{69}Ga do not vary smoothly with N and Z, it is doubtful that a generalized type of calculation (e.g. Kisslinger–Kumar) can provide a very good fit to levels in the region. The log ft value of 8.6 for the β^- transition from $1/2$ ^{69g}Zn to the $1/2^-$ level at 318 keV in ^{69}Ga is among the largest known for allowed transitions. The half-lives of the species studied were determined to be ^{69g}Zn, 55.6 ± 1.6 min; ^{69m}Zn, 14.4 ± 0.1 hr; and ^{69}Ge, 39.05 ± 0.10 hr. A value of 0.102 ± 0.004 was obtained for the isomer-yield ratio ^{69m}Zn/^{69g}Zn in the ^{68}Zn(n,γ)^{69}Zn reaction. (auth)

13248 CIRCULAR POLARIZATION OF γ RADIATION AFTER CAPTURE OF POLARIZED THERMAL NEUTRONS. Abrahams, K.; Ratynski, W. (Reactor Centrum Nederland, Petten, Netherlands). Nucl. Phys., A124: 34-8(1969).

With a Ge(Li) spectrometer, the circular polarization of γ radiation due to capture of polarized thermal neutrons in K, Ca, Ti, Co, Cd, and Pb was determined from transmission measurements through magnetized iron cobalt alloy. The following unambiguous spin assignments result from these measurements (E_x in keV); J(2290) = 2 in ^{40}K; J(3174) = $1/2$ in ^{49}Ti; J(785) = 5 in ^{60}Co. For several other states, the number of possible J-values was reduced considerably. (auth)

13249 SPIN ASSIGNMENTS AND DECAY MODES OF LOW-LYING STATES IN ^{42}Sc. Nicholas, F. M.; Lawley, N.; Main, I. G.; Thomas, M. F.; Twin, P. J. (Univ. of Liverpool). Nucl. Phys., A124: 97-110(1969).

A Ge(Li) spectrometer was used in a study of the ^{40}Ca(^{3}He,pγ)^{42}Sc reaction to accurately measure the following excitation energies of low-lying states in ^{42}Sc: 611.5 ± 0.5, 618 ± 2, 1490.8 ± 0.7, 1511 ± 2, 1586.5 ± 0.7, 2188.5 ± 0.9, 2223.0 ± 0.9, and 2270.0 ± 0.9 keV. The previously reported level at 1880 keV was established to be a doublet; the principal decay modes of all the above states were determined. Gamma-ray angular correlations were measured leading to the assignment of spin 1 to the states at 611.5 keV, 2223.0 keV and one member of the doublet at 1880 keV. The spin of the 1490.8 keV state was limited to 2 or 3 and it was further shown that only spin 3 is consistent with the assignment of spin 5 to the 1511 keV state. The ground state of ^{42}Ti has been shown to decay to the 611.5-keV state in ^{42}Sc with a half-life of 0.20 ± 0.02 sec. (auth)

13250 GAMMA TRANSITIONS IN ^{60}Ni FOLLOWING THE β^+ DECAY OF ^{60}Cu. Rauch, F. (Franklin Inst., Swarthmore, Pa.); Van Patter, D. M.; Hinrichsen, P. F. Nucl. Phys., A124: 145-64(1969).

The γ-transitions in ^{60}Ni following the decay of ^{60}Cu were investigated using a Ge(Li)−NaI(Tl) coincidence-anticoincidence spectrometer. More than 20 previously unreported γ transitions were observed, and six additional levels at 4007.8, 4318.8, 4760.7, 4843, (4848) and (5046) keV were found to be directly populated. A new 120.5 ± 0.3-keV branch (3.5%) between the 3_1^+ (2626.2 keV) and the 4_1^+ (2505.7 keV) states was identified; it accounts for the major part of the M1 decay of the 3_1^+ state. The branching of the 3124.1-keV 2_3^+ state to the 0_1^+ ground state and to the 2284.9-keV 0_2^+ state yields $B(E2: 2_3^+ \rightarrow 0_2^+)/B(E2: 2_3^+ \rightarrow 0_1^+) = 68 \pm 7$. On the basis of available evidence, $J^\pi = 2^+$ is tentatively assigned to the 3269.4- and 3393.5-keV levels. (auth)

13251 LEVELS IN ^{31}P EXCITED IN THE ^{30}Si(p,γ)^{31}P REACTION BY 3- TO 4-MeV PROTONS. Wiechers, G. (Univ. of Cape Town); McMurray, W. R.; Van Heerden, I. J. Nucl. Phys., A124: 165-76(1969).

In the proton energy range E_p = 2.995 to 4.006 MeV, 48 resonances were observed in the reaction ^{30}Si(p,γ)^{31}P. Angular distributions of the ground state decay γ rays yielded unique spins for 21 of these resonance levels in ^{31}P. Angular correlation of the decay γ rays through the first and second excited states of ^{31}P were measured for 17 resonance states yielding 15 spin assignments. The parity of a number of levels was deduced from the measured radiation widths and mixing parameters. (auth)

13252 THE LOW-LYING $K^\pi = 3/2^-$ ROTATIONAL BAND IN ^{43}Sc. Johnstone, I. P.; Payne, G. L. (Univ. of Maryland, College Park). Contract ORO-3765-8. Nucl. Phys., A124: 217-24 (1969).

It is shown that the mixing of (fp)^3 states with a low-lying K = $3/2$ rotational band can account for the observed normal-parity level scheme, spectroscopic factors, and electromagnetic transitions in ^{43}Sc. (auth)

13253 A STUDY OF THE ^{26}Mg(p,t)^{24}Mg AND ^{26}Mg(p,^{3}He)^{24}Na REACTIONS AT 50 MeV. Kingston, F. G. (London Univ.); Griffiths, R. J.; Johnston, A. R.; Gibson, W. R.; McClatchie, E. A.; Megaw, J. H. P. C. Nucl. Phys., A124: 225-33(1969).

The reactions ^{26}Mg(p,t)^{24}Mg and ^{26}Mg(p,^{3}He)^{24}Na were studied at an incident proton energy of 50 MeV. Transitions to the ground state, 1.37, 4.12 + 4.24, 6.00, 7.56 + 7.62, and 15.40 (T = 2) MeV levels in ^{24}Mg and the 1.34- and 5.9-(T = 2) MeV levels in ^{24}Na were observed. The excitation energy of the first T = 2 level in ^{24}Na was measured and that of the first T = 2 level in ^{24}Mg confirmed; the angular distributions of these two transitions were compared. All the observed transitions were analyzed using the distorted-wave formalism. (auth)

13254 A MEASUREMENT OF NUCLEAR MAGNETIC MOMENT OF THE FIRST EXCITED STATE OF ^{48}V. Patnaik, Bijoy Ketan. Pittsburgh, Carnegie-Mellon Univ., 1968. 106p.
Thesis.

The magnetic moment of the 310-keV state (2$^+$) of ^{48}V was measured by the method of perturbed angular correlation. The excited state was produced in the decay of ^{48}Cr (23 hrs). The source was prepared by ^{46}Ti(α,2n)^{48}Cr and ^{50}Fe(p,(xn,yp))^{48}Cr reactions, extracted into a peroxy complex of ether and finally in the form of a dilute solution of $BaCrO_4$ in HNO_3. The unperturbed γ-γ correlation yielded $A_2 = -0.057 \pm 0.015$, $A_4 = -0.055_5 \pm 0.022$. The lifetime of the state was measured electronically and found to be 10.2 ± 0.2 ns. An integral perturbed angular correlation measurement in an external magnetic field of 14.2 kgauss with a coincidence resolving time τ_R = 30 ns gave the result $\mu = 0.44 \pm 0.19\ \mu_n$. An estimate of the time dependent quadrupole attenuation factor g_2 was obtained from a parametric fit of the perturbed correlation in the magnetic field and was found to be 0.97. A fixed angle (3 π/4), reversed field measurement yielded $\mu = 0.51 \pm 0.23\ \mu_n$. The results are consistent with those of Auerbach et al. The unperturbed correlation results gave δ (≡E2/M1) for the 116-keV transition from the second to the first excited state, $\delta = -3.05 \pm 0.45$ or 0.045 ± 0.045. The large error associated with A_4 does not make it possible to resolve these two possibilities for δ. The results are discussed in the light of the $(f_{7/2})^3$ configuration model, taking into account the renormalization of the nucleonic g-factors due to magnetic polarization of the closed shell. The measured values of the magnetic moment of the 2$^+$ state as well as that of the ground state (I = 4) favor configurations $[(j_p^3)_{7/2}(j_n^{-3})_{7/2}]_I$ over $[(j_p^3)_{5/2}(j_n^{-3})_{5/2}]_I$. (Diss. Abstr.)

13255 THE ^{40}A(p,γ)^{41}K REACTION AT THE 1.1-MeV ISOBARIC ANALOGUE RESONANCE. Nickles, Robert Jerome. Madison, Wis., Univ. of Wisconsin, 1968. 152p.
Thesis.

The ^{40}Ar(p,γ)^{41}K reaction was examined at four resonances at E_p = 1.1, 1.58, 1.72, and 1.86 MeV using thick gas targets and Ge(Li) detectors. These resonances correspond to excitation energies of 8.88, 9.34, 9.48, and 9.61 MeV in ^{41}K. The 1.1-, 1.58-, and 1.86-MeV resonances are isobaric analogues of the second, third, and fourth excited states in ^{41}Ar at 0.517, 1.035, and 1.354 MeV. Primary branching ratios were measured for the upper three resonances and the complete decay scheme was resolved for the 1.1-MeV resonance. This decay involves 59 gammas linking 28 levels as shown by the efficiency-calibrated Ge(Li) singles spectra and Ge(Li)/NaI coincidence spectra. The gamma ray angular distributions for the 14 strongest transitions were measured. The analysis of gamma branching and angular distributions was based on the assumption that the experimental beam resolution would equally populate the $J^\pi = 3/2^-$ fine structure capture levels within the spreading width of the $J^\pi = 3/2^-$, $T = 5/2$ analogue state. This should ensure that the gamma de-excitation is characteristic of the undissolved analogue state and not due to any individual fine structure resonance visible with better proton energy resolution. Branching considerations give evidence for $J^\pi = 5/2^+$ states at 2.71, 3.605, 3.755, 3.846, and 4.02 MeV. Of the eight multipole mixing ratios measured, most show considerably more mixing than expected on the basis of single particle considerations. Finally, no evidence was found for the fast M1 primary transitions to high-lying anti-analogue states, a characteristic of the gamma decay of some isobaric analogue resonances. (Diss. Abstr.)

13256 NUCLEAR ENERGY LEVELS OF ^{31}S AND ^{33}Cl. Moss, Calvin Elroy. Pasadena, Calif., California Inst. of Tech., 1968. 314p.
Thesis.

The reaction ^{32}S(^{3}He,α)^{31}S was used to locate 42 levels in ^{31}S. For 11 of the first 17 levels l_n-values were determined. The first 6 excited states of ^{31}S were studied by applying the particle-gamma correlation method of Litherland and Ferguson (their Method II) to the reaction ^{32}S(^{3}He,$\alpha\gamma$)^{31}S. The resulting spins and parities are: E_x, J^π = 1.25 MeV, $3/2^+$; 2.23 MeV, $5/2^+$; 3.08 MeV, $1/2^+$; 3.29 MeV, $5/2^+$, $3/2^+$; 3.35 MeV, $7/2$, $3/2$; 3.44 MeV, $3/2^+$. Mixing and branching ratios were also determined. The ground state Q-value for the reaction ^{32}S(^{3}He,α)^{31}S was measured to be 5.538 ± 0.006 MeV. Analysis of the spectra of the reaction ^{32}S(^{3}He,d)^{33}Cl which were obtained as a by-product of the spectra of the reaction ^{32}S(^{3}He,α)^{31}S located levels in ^{33}Cl at the following excitation energies: 0, 810 ± 9, (1978 ± 14), 2351 ± 9, 2686 ± 8, 2848 ± 9 (a known doublet), 2980 ± 9, and 4119 ± 10 keV. The 2.0-MeV level was only weakly populated and to confirm its existence the reaction ^{36}Ar(p,α)^{33}Cl was studied. In this reaction the 2.0-MeV level was strongly populated; and the measured excitation energy was 1999 ± 20 keV. The experimental results for ^{31}S and ^{33}Cl were compared with their analogs and with nuclear model predictions. (Diss. Abstr.)

13257 DOPPLER-SHIFT LIFETIME MEASUREMENTS IN THE EVEN NICKEL ISOTOPES. Bertin, Michael Charles. New Brunswick, N. J., Rutgers-The State Univ., 1968. 211p.
Thesis.

Mean lifetimes of fourteen states in ^{58}Ni, and one state in ^{62}Ni were measured by the Doppler shift attenuation method. Lower limits were set on three other lifetimes in ^{58}Ni and one in ^{60}Ni. An experimental check on the centroid shift variant of the Doppler shift attenuation method was performed. The lifetime of the first excited state of ^{58}Ni, which is known from Coulomb excitation measurements, was remeasured using inelastically scattered protons, alpha particles, and ^{16}O ions under conditions such that the total stopping cross section and the relative amounts of nuclear and electronic stopping varied markedly. The attenuation factor calculated using the Lindhard, Scharff, and Schiøtt stopping cross sections and the Blaugrund scattering correction yielded lifetimes for the first excited state which were in good agreement with the previous measurement for all three incident projectiles. The spins and parities, and the decay modes of most of the levels studied, are known so that 25 reduced transition matrix elements for E1, E2, and M1 decays in ^{58}Ni could be extracted. Three matrix elements were extracted from the ^{62}Ni lifetime measurement. The measured transition strengths in ^{58}Ni and ^{62}Ni were observed to have the same systematic properties as transition strengths in nuclei with $A < 40$. The E2 transition strengths ranged from 10^{-2} Weisskopf single particle units (Wu) to 15 Wu, the M1 transition strengths ranged from 10^{-4} to 10^{-1} Wu, and the one E1 transition strength was 8.7×10^{-4} Wu. In general, the transition strength decreased with increasing transition energy, both for E2 and M1 decay modes. The individual transition rates were compared with some recent shell model calculations which assumed an inert ^{56}Ni core. The agreement with experiment was found to be poor, possibly due to the improper treatment of core excitations. These discrepancies stimulated theoretical calculations which include the effect of 3 particle–1 hole configurations in ^{58}Ni. (Diss. Abstr.)

13258 STUDY OF THE ^{58}Fe(p,γ)^{59}Co REACTION. de Meijer, R. J.; Nordhagen, R. (Univ. of Oslo). Phys. Norv., 3: 23-30 (1968).

The yield of the reaction ^{58}Fe(p,γ)^{59}Co was measured between 1200- and 2250-keV proton energy. Among the large number of resonances found, the widths of the resonances at 1345 keV ($\Gamma <$ 50 eV), 1997 keV ($\Gamma <$ 50 eV), 2052 keV ($\Gamma <$ 50 eV), 2223 ($\Gamma =$ 150 ± 70 eV), 2234 keV ($\Gamma =$ 570 ± 70 eV), and 2246 keV ($\Gamma =$ 310 ± 70 eV), were determined. The λ-ray spectra of the 1938- and 1997-keV resonances were studied with NaI counters and a Ge counter, and the decay of the ^{59}Co states at 1.479, 1.743 and 2.061 MeV was found to be compatible with the spin assignments $J =$ 5/2, 7/2, and 7/2 for the three states, respectively. The resonance decays support earlier interpretations of the lower ^{59}Co states in terms of a one-phonon coupled multiplet. The resonance at 1997 keV was tentatively identified as the isobaric analogue state of the ^{59}Fe ground state, giving a value of 8.59 ± 0.04 MeV for the ^{59}Co Coulomb displacement energy. The efficiency calibration of the Ge-counter is described. (auth) (NORWAY)

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Refer also to abstracts 11590, 11841, 12965, 13196, 13204, 13226, 13232, 13236, 13239, 13248, 13310, and 13315.

13259 (ANU-P–417) THE SPIN OF THE 2.516-MeV LEVEL OF ^{140}Ce. Cords, H. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1968]. 3p. Dep.

Evidence for the existence of a level at 2.5161 MeV with a spin assignment of 4 is presented on the basis of previous γ–γ angular correlation measurements. The mixing ratio of the 432.5-keV γ ray depopulating this level is $\delta(E2/M1) = 0.032 \pm 0.009$. (D.C.W.)

13260 (ANU-P–420) THE LOW LYING EXCITED STATES OF ^{103}Rh. Black, J. L.; Caelli, W. J.; Watson, R. B. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1968]. 45p. Dep.

The decay scheme for the nucleus ^{103}Rh was studied and revised. The excited states were populated either through the Coulomb excitation of ^{103}Rh or through the nuclear reaction ^{103}Rh(p,p′)^{103}Rh*. The B(E2) values were extracted from the Coulomb excitation data. The proposed level scheme is discussed in terms of a vibrational model for ^{103}Rh, in which it is assumed that most of the negative-parity states arise from the coupling of a $2p_{1/2}$ proton to the vibrational states of the neighboring doubly-even core nucleus. (auth)

13261 (CNEA-214) RELATIONS OF CROSS SECTIONS FOR THE FORMATION OF THE ISOMERS ^{87m}Y AND ^{87}Y IN THE NUCLEAR REACTION ^{90}Zr (d,αn). Fanchiotti, A.; Andrade, O.; Mocoroa, A.; Nassiff, S. J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1968. 9p. (In Spanish). Dep.

The cross-section ratio for the isomers ^{87m}Y and ^{87}Y produced by (d,αn) reaction on Zr was determined as a function of the energy of the incident particle. It was found that the ratio increases as the energy of the deuterons varies between threshold and 27.00 MeV. (tr-auth)

13262 (JINR–P7–4199) PERSPECTIVES IN THE SYNTHESIS OF NEW ISOTOPES AND ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 24p. (In Russian). (CONF-680702–6). Dep.

From International Symposium on Nuclear Structure, Dubna, USSR.

The perspectives in the synthesis of new isotopes and elements are discussed. The methods of new element production neutron reactions, high-energy proton reactions, heavy ion reactions, and fission from excited states are considered. The possibility of the existence of stable superheavy nuclei and methods of synthesizing various isotopes of elements with Z from 114 up to 126 are discussed. (auth)

13263 (ORO–3638–6) TIME-OF-FLIGHT SPECTRA OF FOIL TRANSMITTED FISSION FRAGMENTS OF ^{252}Cf. Moore, Harold J. Jr. (Murray State Univ., Ky.). Aug. 1968. Contract AT(40-1)-3638. 10p. Dep. CFSTI.
Thesis.

An experimental time-of-flight spectrum resulting from individual fission fragments of ^{252}Cf was compared with a calculated spectrum. The time resolution of the system was estimated to be 0.75 nsec. The use of the experimental system is found suitable for future determination of mass. The resulting standard deviation is estimated to be approximately 5 amu. (auth)

13264 (ORO–3785-1) ANGULAR MOMENTUM EFFECTS IN NUCLEAR REACTIONS. Progress Report, April 1, 1968–December 31, 1968. Natowitz, J. B. (Texas Agricultural and Mechanical Univ., College Station. Research Foundation). Jan. 1, 1969. Contract AT(40-1)-3785. 17p. Dep. CFSTI.

Track detectors have been employed to measure the fraction of the total reaction cross section which is accounted for by total momentum transfer events in the interaction of ^{12}C, ^{16}O, and ^{20}Ne with Al, Cu, Ag, Au, and Bi targets. Scanning of these experiments is still in progress. Preliminary results indicate that for 8- to 10-MeV/AMU projectiles, about 70% of the ^{16}O + Cu and ^{16}O + Au reactions and about 30% of the ^{20}Ne + Cu and ^{20}Ne + Ag reactions are total momentum transfer events. Experiments designed to locate and characterize new spontaneous fission isomers are described. An isomer with $T_{1/2} = 1$ to 5 nanoseconds, produced in the bombardment of ^{238}U with 70-MeV α particles, is reported. No mass assignment has yet been made. A search for the isotopes ^{234,235,236}Am is underway. The time dependence for the molecular plating of ^{237}Np at 600 V and 1.5 mA is reported. (auth)

13265 (RPI–328-142, pp 1-67) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Neutron capture measurements were made on natural Cr and Fe samples from 45 to about 400 keV using a fast-slow coincidence system; the energies of resonances in Cr were determined. Capture and transmission experiments were performed on enriched samples of ZrO_2; resonance energies and areas were obtained for ^{90}Zr, ^{91}Zr, ^{92}Zr, and ^{94}Zr. The analysis of radiative capture measurements on F, Mg, and S in the energy range from 10 to 130 keV was extended to include the effects of multiple scattering in determining the values of the radiative widths of pronounced resonances. The correlation of the average fission neutron multiplicity for ^{239}Pu with resonance spin in the energy range from 20 to 100 eV was investigated. The neutron capture-to-fission ratio for ^{239}Pu was measured in the energy range from 0.01 to 30 keV. Resonance neutron scattering by ^{239}Pu at low energies was investigated; resonance spins and widths were determined. Resonance γ spectra from neutron capture by ^{186}W at energies of 40 eV to 5 keV were measured. Gamma spectra from neutron inelastic scattering by Fe at 2 to 4 MeV were obtained using a Ge(Li) crystal. Capture and transmission data on ^{177}Hf were analyzed; radiative widths for resonances at 10.92, 13.60, and 13.89 eV were extracted by shape analysis. The total neutron cross section of ^{148m}Pm was measured over the energy range 0.01 to 400 eV. Capture measurements were made on Fe in the energy range from 4 to 50 eV in an attempt to observe low-energy resonances. Neutron yields from Pb, Ta, U, and composite Ta–U photoneutron targets were also measured. (D.C.W.)

13266 (UCRL-71092) DECAY OF ^{155}Tb TO LEVELS IN ^{155}Gd. Meyer, R. A.; Gunnink, R. (California Univ., Livermore. Lawrence Radiation Lab.). June 25, 1968. 11p. (CONF-680703-4). Dep. CFSTI.

From International Conference on Electron Capture and Higher Order Processes in Nuclear Decay, Debrecen, Hungary.

The electron-capture decay of ^{155}Tb was studied by γ ray spectroscopy. By using a Compton suppression spectrometer and a high-resolution Ge(Li) detector (full width at half maximum of 530 eV for a 60-keV γ ray) approximately 80 γ rays were detected in the decay of isotopically separated ^{155}Tb. The energies of the more intense peaks were measured to a precision of 40 eV. The energy of the γ rays below 350 keV are found to be in agreement with the corrected conversion electron data of Kormicki et al. (auth)

13267 MOESSBAUER EFFECT MEASUREMENTS IN $^{176\ 178\ 180}$Hf. Snyder, R. E.; Ross, J. W.; Bunbury, D. St. P. (Univ. of Manchester, Eng.). J. Phys., C (London), 1: 1662-9 (Dec. 1968).

The Moessbauer effect was used to study the $2^+ \rightarrow 0^+$ gamma-ray transitions in ^{176,178,180}Hf. Using absorbers of Hf metal, HfO_2 and HfB_2, the ratios of the quadrupole moments of the first excited 2^+ levels of the three isotopes were found to be $^{176}Q/^{178}Q = 1.040 \pm 0.008$, $^{178}Q/^{180}Q = 1.014 \pm 0.013$, and $^{176}Q/^{180}Q = 1.053 \pm 0.015$. The isomer shifts between Hf metal and HfO_2 for the three isotopes were found to be $\Delta E(^{176}Hf) = 0.21 \pm 0.10$ mm s^{-1}, $\Delta E(^{178}Hf) = 0.09 \pm 0.03$ mm s^{-1}, and $\Delta E(^{180}Hf) = 0.10 \pm 0.06$ mm s^{-1}. Based on estimates of electronic wave functions, these isomer shifts are shown to correspond to changes in the mean square radius between the first excited and ground states which are a factor of 3 to 5 lower than those predicted by the self-consistent cranking model. Quadrupole splittings were observed at the hafnium sites in $Hf(NO_3)_4$, $HfOCl_2$, $8H_2O$ and $HfCl_4$. Evidence was found for an effective magnetic field at the hafnium sites in the intermetallic compounds $HfCo_2$, Co_2HfAl and $Zr_{0.5}Hf_{0.5}Fe_2$. (auth) (UK)

13268 NUCLEAR DIPOLE, QUADRUPOLE, AND OCTUPOLE MOMENTS OF ^{155}Gd BY ATOMIC BEAM MAGNETIC RESONANCE. Unsworth, P. J. (Univ. of Sussex, Brighton, Eng.). J. Phys., B (London), 2: 122-34(Jan. 1969).

Hyperfine structure measurements were made by atomic beam magnetic resonance in weak fields on the J = 2, 3, 4, 5, and 6 states of the $4f^7 5d6s^2\ {}^9D$ ground fine-structure multiplets in ^{155}Gd and ^{157}Gd. These revealed a 2 : 1 ratio in the effective radial integrals $\langle r_{5d}^{-3} \rangle$ associated with the $l \cdot I$ and $(sC^{(2)})^{(1)} \cdot I$ parts of the magnetic dipole interaction as a result of configuration mixing. Significant relativistic effects were found in the quadrupole interaction, and the ratios $^{157}A/^{155}A = 1.311\ 43(23)$ and $^{157}B/^{155}B = 1.065\ 34(3)$ were established. Further measurements in kilogauss magnetic fields by triple resonance on the state J = 3 gave the dipole moment $^{155}\mu_I = -0.2584(5)$ nm (after diamagnetic correction), the electric quadrupole moment $^{155}Q = 1.59(16) \times 10^{-24}$ cm^2, and showed the existence of a measurable octupole interaction. After making second-order hyperfine structure corrections, an unusually large octupole moment $^{155}\Omega = -1.6(6) \times 10^{-24}$ nm cm^{-1} was deduced. (auth) (UK)

13269 LEVEL SCHEME AND γ TRANSITIONS IN ^{129}I. Burmistrov, V. R.; Shilin, V. A.; Shakhvorostova, G. V.; Kochetkov, V. L. Vestn. Akad. Nauk Kaz. SSR, No. 7, 40-2(July 1968). (In Russian).

The decay of ^{129}Te, obtained from the reactions $^{128}Te(d,p)^{129}Te$ and $^{130}Te(n,2n)^{129}Te$, was investigated using Ge(Li) γ detectors. The energies and intensities of the γ lines observed were determined. A level scheme is proposed for ^{129}I. (R.V.J.)

13270 NUCLEAR ORIENTATION OF ^{111}Cd BY OPTICAL PUMPING WITH THE RESONANCE LINE 5^1S_0–5^1P_1. Lehmann, J. C. (Centre National de la Recherche Scientifique, Paris). Phys. Rev., 178: 153-60(Feb. 5, 1969).

Nuclear orientation by optical pumping of a diamagnetic ground state can only be performed efficiently if the hyperfine structure of the excited state is at least of the order of magnitude of its natural width. Furthermore, the efficiency of such a nuclear orientation varies very much with the intensity of the applied magnetic field. In a field high enough to decouple totally the hyperfine structure of the excited state, this efficiency tends to zero. Several new effects which were predicted in such situations have been experimentally verified in the case of ^{111}Cd, the I = ½ nuclear spin of which being oriented by optical pumping by the $5^1S_0 - 5^1P_1$ resonance line at 2288 Å. Indeed, the 5^1P_1 level has a hyperfine structure which is of the same order of magnitude as its natural width. Among these new effects is an interesting possibility of optical pumping of a spin ½ without the use of a polarizer for intermediate values of the magnetic field, and a shift of the nuclear magnetic resonance in the ground state due to "hyperfine coherences" existing in the excited state. The sign of the hyperfine structure of the 5^1P_1 level of ^{111}Cd, previously unknown, was experimentally measured and found positive; and several new methods were proposed to measure very small hyperfine structures. The situation discussed is closely related to what is known as "anticrossing" of the energy levels. (auth)

13271 ISOMER YIELD RATIO OF ^{115m}Cd AND ^{115g}Cd IN CHARGED-PARTICLE-INDUCED FISSION. Kjelberg, A.; Pappas, A. C.; Tunaal, T. (Univ. of Oslo). J. Inorg. Nucl. Chem., 31: 257-62(Feb. 1969).

The isomer yield ratio of 43-day ^{115m}Cd ($11/2^-$) to 23-day ^{115g}Cd ($1/2^+$) was determined as a function of energy in the fission of uranium induced by 10.5- to 24.0-MeV protons. A sharp decrease in the ratio with energy was found. Whereas this is in accordance with previous results obtained with deuterons, it does not confirm the trend indicated for protons. (auth) (UK)

13272 EQUILIBRIUM DEFORMATIONS OF NUCLEI WITH $50 < Z < 82$, $50 < N < 82$. Arsenev, D. A.; Malov, L. A.; Pashkevich, V. V.; Sobiczewski, A.; Solovev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 883-91 (1968). (In Russian).

The dependence of the ground-state energies of even-even nuclei with $50 < Z < 82$, $50 < N < 82$ on the β and γ deformations was studied. Equilibrium deformations and the deformation energies were calculated. It was shown that for the nuclei in the region of interest the energy difference between the prolate and oblate shapes of the ellipsoid is very small and the total energy has one minimum either at $\gamma = 0$ or 60°. (auth)

13273 PARAMETERS OF NEUTRON RESONANCES OF SEPARATED Sb ISOTOPES. Muradyan, G. V.; Adamchuk, Yu. V.; Shchepkin, Yu. G. (Kurchatov Inst. of Nuclear Power, USSR). Yadern. Fiz., 8: 852-64(1968). (In Russian).

Results of the measurement of the total neutron cross section and of the cross sections of radiative capture of ^{121}Sb and ^{123}Sb are given. The measurements were performed by the time-of-flight method with the resolution 4 and 12 nsec/m. Resonant level parameters and strength functions were obtained. Statistical properties of the level parameters were investigated. (auth)

13274 PROPERTIES OF ISOTOPES $^{206\ 214}$Ra. Lobanov, Yu. V.; Druin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 8: 849-51(1968). (In Russian).

Synthesis of the new isotopes $^{206-214}$Ra in the reactions $Pt(^{22}Ne,xn)Ra$ was carried out in the inner beam of the 310-cm cyclotron of JINR. The isotopes were identified by means of the excitation functions. The α-decay properties of the isotopes $^{206-214}$Ra were determined. (auth)

13275 INVESTIGATION OF THE DECAY CHAIN $^{118}Te \rightarrow {}^{118}Sb \rightarrow {}^{118}Sn$. Kiselev, B. G.; Burmistrov, V. R. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 8: 1057-62 (Dec. 1968). (In Russian).

The spectra of γ and β rays from ^{118}Te were investigated by means of a Ge(Li) spectrometer and a scintillation β spectrometer. The γ transitions with energies of 94, 102, 933, 1293.7, 2239.8, 2844.5, 2962.5, 3084, and 4280 keV and two components of the β spectrum with endpoint energies of 2290 ± 50 and 1300 ± 80 keV were detected. The decay schemes of ^{118}Te and ^{118}Sb are discussed. (auth)

13276 SPECTRA OF γ RAYS EMITTED AT THE THERMAL-NEUTRON CAPTURE BY Nd ISOTOPES. Groshev, L. V.; Dvoretskii, V. N.; Demidov, A. M.; Rakhimov, A. S. Yadern. Fiz., 8: 1067-79(Dec. 1968). (In Russian).

Spectra of γ rays emitted following the absorption of thermal neutrons by samples enriched in the isotopes ^{142,143,144,145,146}Nd were measured by means of a Ge(Li) spectrometer. In addition, the spectrum was obtained for the natural mixture of the isotopes both with a Ge(Li) detector and with a Compton magnetic spectrometer. Energies and intensities of the γ lines isolated from the spectra were determined. Using the data the schemes of the γ transitions were constructed for five Nd isotopes. For the first time, data on the γ transitions in the odd Nd isotopes after the thermal-neutron capture were obtained. These isotopes are of interest because there are one (^{143}Nd), three (^{145}Nd), and five (^{147}Nd) neutrons beyond the filled neutron shell. It was found that for all these nuclei the fairly intense and high-energy transitions proceed to levels at energies of about 0.6 to 0.8 MeV. These levels probably have a considerable contribution from the configurations $3p_{3/2}$ and $2f_{7/2}$ plus a one-phonon excitation at the quantum numbers $3/2^-$. Meanwhile no transition to the ^{145}Nd level with the configuration $(2f_{7/2})^3{}_{7/2}{}^-$ was detected. The γ-transition schemes for the most completely investigated even-even nuclei ^{144}Nd and ^{146}Nd are also discussed. (auth)

13277 CHARGE AND MASS DISTRIBUTION RADII OF NUCLEI. Afanas'ev, N. G.; Shevchenko, N. G.; Savitskii, G. A.;

Gulkarov, I. S.; Khvastunov, V. M. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 8: 1112-17(Dec. 1968). (In Russian).

Data on the charge and mass distribution radii for nuclei, obtained from electron, proton, and α-particle scattering experiments, were analyzed. It was found that the mean square radii of the charge distribution for medium and heavy nuclei are governed by the law $(2Z)^{1/3}$; and for the mass distribution radii the law $A^{1/3}$ is valid. (auth)

13278 DISTRIBUTION OF RARE-EARTH RADIONUCLIDES IN THE FISSION OF ^{238}U AND ^{232}Th. Thein, Myint. Fayetteville, Ark., Univ. of Arkansas, 1968. 68p.

Thesis.

The distribution pattern of the rare-earth radionuclides produced by fission bombs in rains and particles was studied. The mass-yield curve of the rare-earth fission products was very similar to the shape of the ^{235}U thermal neutron-induced fission mass-yield curve. ^{91}Y was found to be depleted in rains and much more in particles, while the other rare earths were not depleted due to their typical refractory behavior. Cumulative fission yields of thirteen mass chains were determined from the fission of ^{232}Th by 14.8-MeV neutrons using improved radiochemical techniques with emphasis placed on the rare-earth region, covering the mass numbers from 141 to 157. The fission yields obtained are as follows: ^{91}Y = 5.94 ± 0.60%, ^{93}Y = 5.76 ± 0.60%, ^{99}Mo = 2.00 ± 0.10%, ^{141}Ce = 5.78 ± 0.70%, ^{143}Ce(^{143}Pr) = 5.26 ± 0.50%, ^{144}Ce = 5.12 ± 1.54%, ^{145}Pr = 5.06 ± 0.50%, ^{147}Nd = 1.70 ± 0.12%, ^{149}Pm = 0.66 ± 0.07%, ^{151}Pm = 0.16 ± 0.03%, ^{153}Sm = 0.085 ± 0.010%, ^{156}Sm(^{156}Eu) = 0.036 ± 0.007%, and ^{157}Eu = 0.012 ± 0.006%. (Disser. Abstr.)

13279 STUDY OF THE DECAY ^{95}Zr → ^{95}Nb. Foin, C. (Institut des Sciences Nucleaires, Grenoble, France); Oms, J.; Blachot, J.; Crancon, J. Nucl. Phys., A123: 513-20(1969). (In French).

The decay ^{95}Zr → ^{95}Nb was studied by means of an iron-free double-focussing β spectrometer and Ge(Li) detectors. The photon relative intensity of the 758-, 724-, and 236-keV transitions was measured. The 236-keV isomeric transition was studied with a Zr-free ^{95m}Nb source; and its energy, half-life, α_K and $\alpha_K/\alpha_{L+M+\ldots}$ were accurately measured. Internal conversion results agree completely with theoretical calculations for an M4 assignment. The number of 724-keV photons per ^{95}Zr decay and β-branching ratios were deduced. (auth)

13280 HIGH-RESOLUTION Ge(Li) STUDY OF THE DECAY OF ^{129g}Te AND ^{129m}Te. Dickinson, W. C.; Bloom, S. D.; Mann, L. G. (Univ. of California, Livermore). Nucl. Phys., A123: 481-96(1969).

The decay of ^{129m}Te and ^{129g}Te to levels in ^{129}I was studied using Ge(Li) detectors for high-resolution γ-ray spectroscopy with some supporting data from NaI(Tl) detectors in coincidence. A total of 46 gamma rays is accounted for by 16 excited states (one tentative) in ^{129}I up to 1401.6 keV. These include ten new gamma rays not previously reported, a new level in ^{129}I at 1282.1 keV ($5/2^+$) and a probable new level at 1204.2 keV ($3/2^+$, $5/2^+$) (values of J^π in parentheses). The decay scheme was arrived at primarily on the basis of precise γ-ray energy determinations (to ±50 eV in many cases and never worse than ±200 eV). Beta-decay log-ft values were determined from γ-ray intensity balances coupled with published β branchings. Most-probable spins and parities were deduced based on the γ-ray branching, the log-ft value and published angular correlations of other workers. The $J^\pi = 1/2^+$ state predicted by Kisslinger and Sorensen in the region of 200 eV and observed in ^{125}I and ^{127}I was not seen; a log ft ≥ 10.6 was found for the allowed β decay from ^{129} Te to such a level. Likewise no evidence was found for the $11/2^-$ state at ≈930 keV as predicted by Kisslinger and Sorensen; the allowed β decay to this state would have log ft ≥ 11.0. (auth)

13281 ON THE ISOMER IN ^{117}Te. Brinckmann, H. F.; Heiser, C.; Hagemann, U. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A123: 689-95(1969). (In German).

An isomer in Te with a half-life of 104 ms and a γ transition of 274 keV was re-investigated by means of the pulse-activation method. The assignment of this activity to an isomer in ^{117}Te followed from excitation in the reactions ^{114}Sn(α,n) and ^{115}Sn(α,2n). The total conversion coefficient and the K/L + M ratio of the 274-keV γ transition were determined; $\alpha_{tot} = 7 \pm 1.5 \times 10^{-2}$; $\alpha_K/\alpha_{L+M} = 4.7 \pm 0.3$. These values agree with the multipole order E2 or E2 + M1. Therefore the 274-keV γ line can not represent the isomeric transition. Because a search for further transitions with a half-life of 104 ms was unsuccessful, it must be assumed that the isomeric transition has a very low energy and remains unobserved. (auth)

13282 SINGLE-HOLE COLLECTIVE MODEL FOR ^{205}Tl AND ^{203}Tl. Azziz, N. (Westinghouse Atomic Power Div., Pittsburgh); Covello, A. Nucl. Phys., A123: 681-8(1969).

The level structure of ^{205}Tl and ^{203}Tl is described by a simple model which couples the $3s_{1/2}$, $2d_{3/2}$, $1h_{11/2}$, $2d_{5/2}$, and $1g_{7/2}$ single-hole states with quadrupole and octupole vibrations of the core. No adjustable parameter appears in the calculation. The calculated energy spectra and electromagnetic transition probabilities are in good agreement with the experimental data. Also, the strong fragmentation of the single-hole strength revealed by the experiments of Hinds et al. is quite well reproduced by the theory. (auth)

13283 ANGULAR DISTRIBUTION OF ^{238}U PHOTOFISSION FRAGMENTS FOR 12 DIFFERENT MONOENERGETIC γ RAYS. Manfredini, A. (Istituto Nazionale di Fisica Nucleare, Rome. Univ., Rome); Fiore, L.; Ramorino, C.; De Carvalho, H. G.; Woelfli, W. Nucl. Phys., A123: 664-72(1969).

Monoenergetic γ rays of 12 different energies in the energy range 5.4 to 9 MeV were used to irradiate ^{238}U. The results of measurements of angular distributions of photofission fragments are reported and discussed. An analysis assuming penetration barrier function was performed, and energies of the K-levels were obtained as well as other nuclear parameters. (auth)

13284 THE STATES OF ^{117}Sn. Beery, D. B. (Michigan State Univ., East Lansing); Berzins, G.; Chaffee, W. B.; Kelly, W. H.; McHarris, Wm. C. Nucl. Phys., A123: 649-63(1969).

Gamma rays emitted in the decay of 2.8-hr ^{117}Sb were investigated with 2.5- to 45-cm^3 Ge(Li) detectors. Gamma rays of energies (and relative intensities) 158.5 (99.6), 553.2 (0.07), 846.2 (0.04), 861.7 (0.29), 1004.5 (0.22), 1020.6 (0.09), 1021.0 (0.10), 1287.6 (0.026), 1339.5 (0.009), 1420.1 (0.016), 1446.4 (0.051), and 1578.0 (0.018) keV were observed. On the basis of energy sums, relative intensities, and two-dimensional Ge(Li)-Ge(Li) coincidence experiments, states are placed in ^{117}Sn at 0 ($1/2^+$), 158.5 ($3/2^+$), 711.7 ($7/2^+$), 1004.5 ($3/2^+$), 1020.2 ($5/2^+$), 1179 ($5/2^+$), 1446.4 ($3/2^+$,$5/2^+$), 1498.0 ($5/2^+$, $3/2^+$) and 1578.3 keV ($5/2^+$, $3/2^+$). The spin assignments and limits were made on the basis of log-ft values and relative photon intensities from ^{117}Sb decay, which were aided in some cases by ^{117}In decay, and also by information gleaned from nuclear reaction data. The structures of the states are discussed in terms of current nuclear models, and the behavior of these states is followed as a function of neutron number. (auth)

13285 PARTIAL RADIATIVE CAPTURE OF RESONANCE NEUTRONS IN TUNGSTEN. Samour, C.; Julien, J.; Alves, R. N.; de Barros, S.; Morgenstern, J. (CEN, Saclay, France). Nucl. Phys., A123: 581-602(1969). (In French).

The possible correlation in ^{184}W between two partial radiative widths relative to transitions to near-lying energy states was investigated with the Saclay linear accelerator using the time-of-flight method and a Ge(Li) detector. The spectra for 13 resonances with spin and parity 1^- were analyzed. The data agree with no appreciable correlation between the two transitions to the ground state and the first excited state of ^{184}W. Information was also obtained on the level schemes of the even-mass deformed nucleus ^{184}W and of odd-mass deformed nuclei ^{183}W, ^{185}W, and ^{187}W. (auth)

13286 THE EXCITATION CURVES FOR THE (n,γ), (n,2n), AND (n,p) REACTIONS IN Ta. Brzosko, J. S.; Gierlik, E.; Soltan, A. Jr.; Wilhelmi, Z. (Univ. of Warsaw. Inst. for Nuclear Research, Warsaw). Nucl. Phys., A123: 603-8(1969).

The excitation curves for the following reactions were measured: ^{181}Ta(n,γ)^{182}Ta for $E_n = 0.03$ to 5.1 MeV, ^{181}Ta(n,2n)^{180m}Ta for $E_n = 12.2$ to 17.9 MeV, ^{181}Ta(n,p)^{181}Hf for $E_n = 13.2$ to 17.5 MeV. The results were compared with the predictions of the statistical theory. (auth)

13287 ELECTRIC MONOPOLE TRANSITIONS OBSERVED IN ^{154}Gd FOLLOWING β DECAY OF ^{154}Eu. Andersson, G. I.; Ewan, G. T. (Chalk River Nuclear Labs., Ont.). Nucl. Phys., A123: 609-15(1969).

The K-conversion electron intensities of transitions in ^{154}Gd with strong E0 components were measured at 0.1% resolution in momentum. Transitions of 692.41, 680.70, and 676.58 keV were observed from the 0^+, 2^+, and 4^+ members of the β-vibrational band to levels with the same spin in the ground-state band. The previously reported transition of 533.6 keV was found to be a doublet of 533.04 and 535.06 keV. Both these transitions have a large E0 component and were tentatively assigned as being between the levels of spin 2^+ and 3^+ of a second K = 2 band and the corresponding 2^+ and 3^+ levels of the K = 2 γ-vibrational band. It is suggested that the upper K = 2 band be interpreted as a β-vibrational band built on the γ-vibrational band. (auth)

13288 EXCITED STATES IN ^{178}Hf FROM RESONANCE NEUTRON-CAPTURE GAMMA-RAY STUDIES. Faler, K. T.;

Spencer, R. R.; Harlan, R. A. (Idaho Nuclear Corp., Idaho Falls). Nucl. Phys., A123: 616-26(1969).

A total of 16 excited states up to 1818 keV in the deformed doubly even nucleus ^{178}Hf were located from observation of the primary gamma rays produced in the reaction ^{177}Hf(n,γ)^{178}Hf. Gamma-ray spectra were obtained at neutron resonances with energies of 1.1, 2.4, 5.9, 6.6, and 8.8 eV. Since the angular momenta of these resonance states are known, the angular momentum quantum numbers of the resulting states were limited to two or at most three values. The level at 1268 keV was studied in a gamma-gamma coincidence measurement and was assigned as a K, I^{π} = 2, 3^+ state. Other members of this K = 2 band appear to be at 1174 keV (2, 2^+) and at 1385 keV (2, 4^+). The neutron separation energy of ^{178}Hf was found to be 7625 ± 1 keV. (auth)

13289 NUCLEAR WAVE FUNCTIONS OF ^{90}Zr AND THE ^{90}Zr(α,α',γ) REACTION. Wold, Donald Clarence. Bloomington, Ind., Indiana Univ., 1968. 414p.

Thesis.

The application of the shell model to the ^{90}Zr(α,α',γ) reaction is described. Computer programs were written for this analysis. The shell-model orbitals are calculated for a potential of the Saxon–Woods shape. The central part of the Gammel and Thaler proton-alpha potential is used for the interaction between projectile and target nucleons. The parameters of the optical potential well are determined by fitting the elastic scattering, and the strength of the proton-alpha interaction is determined by fitting the inelastic cross section for exciting the 2^+ level at 2.18 MeV. The strength of the effective projectile-nucleon interaction required for the inelastic 2^+ excitation is approximately twice that required for elastic scattering of protons from ^{4}He. Core polarization is included in the coupled channel and distorted-wave calculations. The nuclear wave functions of ^{90}Zr are varied by changing the $2p_{1/2}$ and $1g_{9/2}$ single-particle wave functions. Different radial wave functions are obtained by altering parameters of the bound-state potential. The angular distribution of the correlation symmetry angle does not change significantly when different wave functions are used in the calculation of the ^{90}Zr(α,α',γ) reaction. Hence, alpha-gamma angular correlations do not appear to be a useful tool for studying nuclear structure. At least at a laboratory energy of 65.1 MeV, the alpha-gamma angular correlations are not sensitive to changes in the nuclear wave functions. The predicted angular distribution of the differential cross section for exciting the 0^+ level at 1.75 MeV is very sensitive to changes in the nuclear wave functions. Neither the 2^+ nor the 5^- angular distribution shows such striking variations as those observed for the 0^+ angular distribution; both angular distributions are insensitive to changes in the nuclear wave functions. Coupled-channel and distorted-wave calculations show that accurate predictions for the 0^+ level at 1.75 MeV should use the coupled-channel approach. Measurements of the 0^+ excitation could be helpful in resolving questions about the nuclear structure of ^{90}Zr. The code MEGATON, which performs the multipole expansion of the Gammel and Thaler potential, can be easily modified for a different potential. Other forms of the projectile-nucleon interaction can be used. The bound-state wave functions are calculated with the code WAVEFEV. The radial parts of the matrix elements, i.e., the form factors, are calculated with the code FORMFACT. The differential cross sections and the correlation symmetry angle are calculated with the code COUPCHAN. These FORTRAN codes are sufficiently flexible that they can be modified to perform calculations of alpha-particle scattering by other shell-model nuclei. (Disser. Abstr.)

13290 NEUTRON MULTIPLICITY–SPIN STATE CORRELATIONS FOR ^{239}Pu RESONANCES. Weinstein, Simon; Block, Robert C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev. Lett., 22: 195-8(Feb. 3, 1969).

Measurements were made of the fission-neutron multiplicity associated with eleven ^{239}Pu resonances in the energy range from 20 to 100 eV. It has been found that the multiplicity values are strongly correlated with the spins of the individual resonances and that the average multiplicity for the J = 0 group is 2.6% higher than for the J = 1 group. (auth)

13291 ON A DOUBLET IN ^{205}Tl BASED ON THE 3^- STATE IN ^{208}Pb. Solf, J.; Hering, W. R.; Wurm, J. P.; Grosse, E. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 28B: 413-14(Jan. 6, 1969).

Two states at 2.61 and 2.69 MeV in ^{205}Tl were studied by inelastic scattering via analog resonances. They are explained as the $5/2^-$, $7/2^-$ doublet originating from a $s_{1/2}$ proton hole coupled weakly to the 3^- state at 2.65 MeV in ^{208}Pb. (auth)

13292 NUCLEAR LEVEL STRUCTURE OF ^{99}Tc. Bashandy, E.; Ibrahiem, N. (Atomic Energy Establishment, Cairo). Z. Phys., 219: 337-47(1969).

The gamma rays of ^{99}Tc excited through electron decay of ^{99}Mo were studied by internal conversion spectroscopy, using a high-resolution double-focusing beta-ray spectrometer. Conversion electrons were observed for all transitions reported before. In addition, a new gamma ray of energy 989.37 ± 1.02 keV was identified and was ascribed for the first time to the decay of ^{99}Mo. Gamma-ray energies were determined with high precision. Multipolarity data, obtained from the measurements of absolute or ratio of conversion coefficients of gamma rays, were utilized for assigning possible spins and parities to the levels of ^{99}Tc. From the present data combined with other studies, spins and parities of $7/2^+$, $1/2^-$, $5/2^+$, $3/2^-$, $3/2^+$, and $5/2^-$ were given to the 140-, 142-, 181-, 514-, 922-, and 1131-keV levels, respectively. The experimental level scheme is discussed in terms of theoretical predictions. (auth)

13293 MEASUREMENT OF THE NUCLEAR MOMENTS OF THE FIRST EXCITED STATE OF ^{170}Er. Wiggins, James Wendell. Baltimore, Johns Hopkins Univ., 1968. 92p.

Thesis.

Moessbauer effect experiments were conducted to measure the magnetic dipole and electric quadrupole moments of the first excited state of the nucleus of ^{170}Er. The gyromagnetic ratio, g_R, for each of the isotopes ^{164}Er, ^{166}Er, and ^{168}Er has been previously measured by the Moessbauer effect but the present work represents the first Moessbauer study of ^{170}Er. These values of g_R are compared with a calculation on the basis of the unified model of the nucleus. The calculated value of each g_R is lower than the experimental value and outside the assigned limit of experimental error. The calculation does reflect the general way in which the observed value of g_R changes from one isotope to another. A 0.5 μ Ampere beam of 3.0-MeV α particles was used to populate the first excited state of ^{170}Er by Coulomb excitation since there is no suitable β-decay parent available for this isotope. Both the target and the resonant absorber were cooled to 30°K. A constant acceleration velocity transducer repeatedly moved the absorber through the range of ±11 cm/sec relative to the target. Data were accumulated in 512 channels of a multichannel analyzer operating in the multiscaling mode. The intermetallic Laves phase compound, $ErAl_2$ isotopically enriched to 96% ^{170}Er, was used for the target in order to provide a source of γ rays unsplit by hyperfine interactions. This experiment marks the first use of an intermetallic compound as a target in an accelerator induced Moessbauer effect experiment. A similar Laves phase compound, $ErFe_2$, was used as the resonant absorber because of the easily interpretable hyperfine structure observed in it. Five well-resolved absorption lines were observed due to the hyperfine splitting in the absorber. The Moessbauer effect in ^{165}Er was observed using the same absorber and a $HoAl_2$ β-decay source. Direct comparison of the ^{170}Er and ^{166}Er spectra eliminated most systematic errors and allowed determination of the ratios of the nuclear moments without exact knowledge of the internal hyperfine fields. Several changes in the equipment used in this laboratory for Moessbauer effect experiments were made to improve accuracy and stability. A mechanical, closed-cycle, continuous-duty refrigerator was used to cool the target and absorber. This is a unique application of such a refrigerator, and elaborate precautions were taken to isolate the vibrations of the refrigerator from the Moessbauer spectrometer. (Disser. Abstr.)

13294 STUDY OF THE γ RAYS ASSOCIATED WITH THE DECAY OF ^{125}Sb. Sergolle, Henri (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. A and B, 267: 1042-4(Nov. 4, 1968). (In French).

A study of the γ rays associated with the decay by β^- emission of ^{125}Sb with the aid of a germanium detector permitted the level scheme of ^{125}Te to be made more precise. (tr-auth)

13295 EXPERIMENTAL STUDIES OF ^{136m}Ba, ^{134m}Xe, ^{127m}Xe, AND ^{125m}Xe. Winn, Willard Gary. Ithaca, N. Y., Cornell Univ., 1968. 176p.

Thesis.

The isomers ^{136m}Ba, ^{134m}Xe, ^{127m}Xe, and ^{125m}Xe were produced by pulsed neutron irradiation of enriched and natural samples and transported by fast pneumatic transfer to a counting station where γ and conversion electron spectra were observed using NaI(Tl), Ge(Li), and Si(Li) detectors. Because of the short half-lives of the isomers investigated, special techniques were devised to provide fast positioning of the sample for detection. ^{136m}Ba($T_{1/2}$ = 307 ± 4 msec) and ^{134m}Xe($T_{1/2}$ = 290 ± 17 msec) were studied with reference to analogous isomers in the N = 80 isotones. Each isomer decays by a three gamma cascade consistent with a $7^- \xrightarrow{E3} 4^+ \xrightarrow{E2} 2^+ \xrightarrow{E2} 0^+$ scheme. Corresponding gamma energies are 168 ± 7, 1048.6 ± 0.7 and 819.3 ± 0.7 keV in ^{136m}Ba and 232.9 ± 1.5, 879.9 ± 1.4, and 845.9 ± 1.0 keV in ^{134m}Xe. As the isomer ^{134m}Xe had not been observed previously, internal conversion studies were performed to establish the multipolarity of the isomeric transition.

An E3 assignment for the 233-keV transition results from its measured K/LMNO ratio of 1.83 ± 0.32 coupled with the measured gamma intensities of 62.8 ± 8.0, 94.4 ± 6.3, and 100 for the 233-, 880-, and 846-keV transitions, respectively. The conversion electron statistics for the 880- and 846-keV transitions did not allow definite assignments for these transitions; however, the gamma intensities are consistent with the E3 assignments suggested in Nuclear Data Sheets. A comparison of ^{136m}Ba and ^{134m}Xe with other isomers of the N = 80 isotones shows that most of the levels observed in the isomeric decays fit trends suggested by neighboring isomers. Only the assumed 4^+ state of ^{134}Xe disagrees with such trends; the possibility was therefore considered of a second 4^+ state satisfying the level trends and lying near the 7^- isomeric level. The gamma spectra, however, do not indicate that the isomer decays via this alternative 4^+ level, the upper limit for such branching being estimated at 2% of the observed decay mode. The techniques developed for xenon gas samples in the ^{134m}Xe experiments were applicable to investigation of other isomers in xenon. The isomers ^{127m}Xe($T_{1/2}$ = 74 sec) and ^{125m}Xe($T_{1/2}$ = 58 sec) were studied. Each was observed to decay by a two gamma cascade consistent with a $9/2^- \xrightarrow{E3} 3/2^+ \xrightarrow{M1} 1/2^+$ scheme. The corresponding gamma energies are 172.5 ± 1 and 125.1 ± 1 keV in ^{127m}Xe and 142.3 ± 0.5 and 112.1 ± 0.5 keV in ^{125m}Xe. The suggestion in Nuclear Data Sheets that a 75-keV transition also occurs in the decay of ^{125m}Xe was investigated; after examination of various background contributions it was concluded that the 75-keV peaks in various gamma spectra do not correspond to a nuclear transition. The internal conversion measurements on ^{125m}Xe are also consistent with this result: from the assignment of E3 for the 142-keV transition (determined from $\alpha_{LMNO} = 1.83 \pm 0.22$), the assignment of M1 for the 112-keV transition (determined from $\alpha_K = 0.47 \pm 0.07$), and the assumption that the 75-keV peak is not a nuclear transition (thus $\alpha_K = 0$), the K x-ray intensity observed in the spectrum could be explained. The statistical accuracy of the ^{127m}Xe conversion electron lines was not sufficient to make multipolarity assignments; however, the line intensities are consistent with a $9/2^- \xrightarrow{E3} 3/2^+ \xrightarrow{M1} 1/2^+$ decay scheme. (The $1/2^+$ ground state is known for ^{127}Xe and assumed for ^{125}Xe by analogy.) The appearance of a $9/2^-$ state in this nuclear region is not compatible with shell model predictions and suggests that nuclear deformation may be present. For those isomers above which are created by thermal neutron capture, the thermal neutron activation cross sections were measured: $\sigma_{th}(^{136m}\text{Ba}) = 13.9 \pm 0.7$ mb, $\sigma_{th}(^{127m}\text{Xe}) = 0.23 \pm 0.07$ b, $\sigma_{th}(^{125m}\text{Xe}) = 18 \pm 4$ b. These measurements were made for comparison with statistical theories for cross-section ratios. The resonance integrals were also estimated for these isomers. (Diss. Abstr.)

13296 HYPERFINE EFFECTS IN MUONIC X RAYS FROM SEPARATED ISOTOPES OF GADOLINIUM (^{158}Gd AND ^{160}Gd) AND FROM BISMUTH. **Gupta, Parshotam Dass. Pittsburgh, Carnegie-Mellon Univ., 1968. 107p.**

Thesis.

The K and L x rays were observed from muonic atoms of separated isotopes of gadolinium (^{158}Gd, ^{160}Gd) and from bismuth. A modified Fermi charge distribution was used to describe the charge distribution for all these nuclei. Highly deformed nuclei, ^{158}Gd and ^{160}Gd, were analyzed by assuming the validity of the rotational model. Assumptions about the charge density and the rotational model for ^{158}Gd and ^{160}Gd nuclei were found to be sufficient to explain the K and L-spectra of ^{158}Gd and ^{160}Gd. Values of intrinsic quadrupole moments for ^{158}Gd and ^{160}Gd obtained from muonic x rays agreed with those obtained from Coulomb excitation experiments and the experiments on the measurements of half-lives of the excited states of these isotopes. However, values of skin thickness parameter t for ^{158}Gd and ^{160}Gd were found to be unexpectedly low. The values of C and t fitting the K and L-spectra of ^{209}Bi agreed with the results of the electron scattering experiments. The magnetic hyperfine splitting of $2p_{1/2}$-$1s_{1/2}$ transition was found to agree with the predictions of the configuration mixing model and rule out the point dipole model and the single particle model for the magnetic moment of ^{209}Bi. Existence of resonances involving highly excited states of ^{209}Bi in its muonic spectra was confirmed by the measurements of intensity ratios in K and L-spectra and also by the isomeric muonic transitions which accompany such resonances. (Diss. Abstr.)

13297 STUDIES OF THE MOESSBAUER EFFECT IN EVEN-EVEN ERBIUM ISOTOPES FOLLOWING COULOMB EXCITATION. **Russell, David Carrick. New Orleans, Tulane Univ., 1968. 101p.**

Thesis.

Moessbauer experiments were carried out on ^{166}Er, ^{168}Er, and ^{170}Er using Coulomb excitation to populate the first excited states of the nuclei being studied. All experiments were performed with the target (source) at 10 ± 1°K and the absorber at 12 ± 1°K. The experiments employed a beam of 3.3-MeV protons obtained from a Van de Graaff accelerator. Using an enriched $^{170}Er_2O_3$ target and absorber the Moessbauer effect in ^{170}Er was observed. A partially resolved nuclear hyperfine structure resulting from combined magnetic and quadrupole splitting in the traget and absorber was obtained. From the resolved splittings a magnetic interaction energy of $5.54 \pm 0.37 \times 10^{-6}$ eV and an electric interaction energy of $1.61 \pm 0.3 \times 10^{-6}$ eV were obtained. Using independently obtained values of the magnetic field and the electric field gradient in Er_2O_3, the values $g_R^{170} = 0.314 \pm 0.021$ and $|Q_o| = 7.49 \pm 1.43$ barns were extracted. The large splittings observed in this spectrum indicate there is magnetic ordering in Er_2O_3 at 12 to 13°K. A systematic study of the variation of the gyromagnetic ratio of the first excited states of ^{166}Er, ^{168}Er, and ^{170}Er was carried out using the Moessbauer effect following Coulomb excitation. The target in each experiment was isotopically enriched Er_2O_3; the absorber was 0.005 inches of natural erbium metal. From the total splitting in each spectrum the relative values of g_R were obtained. From independently determined values of the internal magnetic field in the target and the absorber, values for g_R in ^{166}Er, ^{168}Er, and ^{170}Er were extracted. The values of g_R are in agreement, within experimental error, with values obtained in other measurements. The trend of the values of g_R^{166}, g_R^{168}, and g_R^{170} is in qualitative agreement with the theoretical values, of Nilsson and Prior based on the rotational model with the inclusions of pair correlations. However, the magnitudes of the experimental g_R values are consistently higher than the theoretical estimate. The results reinforce the conclusions of other investigators that the Coulomb excitation Moessbauer technique produces experimental results comparable in accuracy to those of similar measurements employing radioactive sources. Coulomb excitation Moessbauer studies continue to be a valuable tool for the study of nuclear levels not accessible by radioactive decay. (Diss. Abstr.)

13298 ISOBARIC ANALOGUE STATE STUDIES WITH ^{107}Ag AND ^{109}Ag. **Shugart, Cecil Glenn. Austin, Tex., Univ. of Texas, 1968. 108p.**

Thesis.

Excitation functions for proton elastic and inelastic scattering as well as the (p,n) reaction were obtained from ^{107}Ag and ^{109}Ag targets. The (p,n) reactions provided excitation energies and resonance widths for levels in ^{108}Cd and ^{110}Cd which are isobaric analogues of the low-lying states of ^{108}Ag and ^{110}Ag. Analysis of the proton elastic data produced comparable energies and widths. In addition, proton partial widths were extracted that display the channel spin dependence predicted by theory. Coulomb displacement energies were obtained from these data. Inelastic scattering was utilized to evaluate excited levels in the target nuclei. (Diss. Abstr.)

13299 SPECTROSCOPIC STUDIES OF THE NUCLEI IN THE MASS REGION 90 TO 124 VIA THE (d,p) REACTION. **Moorhead, James Bennett. Pittsburgh, Univ. of Pittsburgh, 1968. 170p.**

Thesis.

Spectroscopic studies of the ^{93}Mo, ^{95}Mo, ^{99}Mo, ^{94}Nb, ^{107}Pd, ^{109}Pd, ^{115}Cd, and ^{116}In nuclei via the (d,p) reaction were undertaken. Deuterons used in this study were provided at a bombarding energy of 12.0 MeV by a tandem Van de Graaff accelerator. Proton energy spectra were obtained with an energy resolution of 7 to 9 keV using an Enge split-pole spectrograph as an analyzer and photographic emulsions as detectors. The l-values were assigned to each of the transitions by examining the shapes of the angular distributions of the cross sections of proton groups. Values of j were assigned from the systematics of the region and (d,t) corroboration where necessary. Spectroscopic factors were calculated for each of the transitions and occupation numbers were assigned to each of the single-particle levels in the nuclei. Centers of gravity were calculated and were used to obtain single-particle energies for each of the single-particle levels. The occupation numbers, "centers of gravity," and single particle energies of each of the single-particle levels were compared among the isotopes studied and to previous work on isotopes of Zr, Mo, Cd, and Sn. These are formed to behave as expected for theoretically s and d levels, but the g and h levels show anomalous behavior. Further investigation at different bombarding energies and for other isotopes in the region is suggested. (Diss. Abstr.)

13300 THE DECAY OF ^{124}Sb TO THE LEVELS OF ^{124}Te. **Auer, I. P.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Phys., A124: 199-211(1969).**

The decay of $^{124}\text{Sb} \rightarrow {}^{124}\text{Te}$ was studied with curved-crystal and Ge(Li) spectrometers and with γ-γ coincidence techniques. Energy and intensity measurements on 38 γ rays are reported. A partial decay scheme is proposed which incorporates 34 of the observed γ rays. Levels at 2483.27 keV, 2701.78 keV and 2710.65 keV are added to the most recently published decay scheme. (auth)

13301 FAST NEUTRON SCATTERING FROM ^{139}La AND ^{141}Pr. Malan, J. G. (Southern Universities Nuclear Inst., Faure, S. Africa); McMurray, W. R.; Van Der Merwe, P.; Van Heerden, I. J.; Engelbrecht, C. A. Nucl. Phys., A124: 111-29(1969).

Using time-of-flight techniques, the isotones ^{139}La and ^{141}Pr were studied by means of elastic and inelastic neutron scattering in the energy range 230 to 2580 keV. The energies of more than 20 levels in ^{139}La and of more than 15 levels in ^{141}Pr were determined. Contrary to results from Coulomb excitation experiments, no evidence was found for levels between 200 and 1100 keV in either nucleus. Excitation functions and angular distributions for scattering to a number of levels in both nuclei were measured. Optical-model parameters were determined from fits to elastic scattering angular distributions and to the excitation functions for scattering to the first excited states. A Hauser–Feshbach analysis of the inelastic data yielded probable spin values for some higher levels. For other levels, the calculations indicated unresolved structure. (auth)

13302 NUCLEAR EXPLOSION EXPERIMENTS TO DETERMINE NUCLEAR PROPERTIES OF HEAVY ISOTOPES. Ingley, John S. (Univ. of California, Livermore). Nucl. Phys., A124: 130-44(1969).

Results of experiments to determine the properties of heavy isotopes from studies of heavy-element yield curves obtained in nuclear explosions, which can not be performed in the laboratory, are reported. In most cases, ^{238}U was used as the target element. Measurements of uranium neutron capture cross sections around 20 keV neutron energy in the mass range 242–249 reveal a decrease at mass 244 corresponding to 152 neutrons, presumably due to the "shell effect". These results agree well with original calculations. No fission competition from mass 242-248 is evident, but a fission-to-capture ratio of 5 for mass 249 appears probable. There is some evidence of thermal fission in the uranium capture chain at ^{239,241}U and strong evidence of thermal fission in the plutonium capture chain. Strong thermal fission competition is indicated in the neptunium capture chain. (auth)

13303 FINE STRUCTURE IN THE REGION OF SYMMETRIC MASS DISTRIBUTION FOR CUMULATIVE FISSION YIELDS. Thind, K. S.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 275-8(Feb. 1, 1969).

It is predicted that there should be fine structure in the cumulative mass yield curve in the symmetric mass region where major discontinuities in the neutron emission vs mass curve exist. In the case of low-energy neutron fission of ^{238}U, this fine structure takes the form of a pronounced depression in the region of mass 125. Under similar conditions for ^{232}Th, the fine structure may take the form of depressions in the region of mass 110 and 125 so that the cumulative mass yield curve appears to have a central peak. (auth) (Canada)

Nuclear Theory

Refer also to abstracts 11466, 13186, 13195, 13203, 13201, 13206, 13222, 13207, 13236, 13272, and 13282.

13304 (ANL-Trans-698) PARITY VIOLATION BY NUCLEAR FORCES. Waeffler, Hermann. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Naturwissenschaften, 55: No. 6, 255-61(1968). 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 46854. (auth)

13305 (COO-1573-48) NUCLEAR PHYSICS LABORATORY PROGRESS REPORT FOR THE PERIOD NOVEMBER 1, 1967–OCTOBER 31, 1968. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Contract AT(11-1)-1573. 42p. Dep. CFSTI.

Previously unreported developments in the experimental research program are summarized including investigations of the scattering of polarized neutrons by ^{12}C, ^{65}Cu, ^{54}Fe, ^{56}Fe, ^{58}Ni, and ^{60}Ni; polarization effects in multiple scattering corrections; neutron elastic and inelastic scattering by ^{59}Co; charged-particle energy loss and straggling in thin foils; analysis of neutron inelastic scattering data by the Griffin model; proton polarization from the reaction ^{13}C(d,p_0)^{14}C; and deuteron reactions and scattering on ^{13}C. Developments in the theoretical research program are also outlined including research on the behavior of charged gases in a neutralizing background, the scattering of high-energy particles by systems of particles, the construction of a generalized spin algebra from the generators of the Poincare group, the Wigner supermultiplet theory of ground-state masses, K-matrix and R-matrix formalism for nuclear reactions, calculation of the lifetime of a metastable system, elastic diffraction scattering of hadrons at high energy, particle production cascades, the ^{48}Ti(p,p′)^{48}Ti excitation function, local pressures in finite systems, the statistical mechanics of the long-range anisotropic Heisenberg model, and the statistical mechanics of a two-dimensional hard-core lattice gas. (D.C.W.)

13306 (FOA-4-4237) FISSION SPECTRA: A LITERATURE SEARCH. Nilsson, I. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr. 1962. 33p. (In Swedish). Dep.

Three different mathematical descriptions of fission spectral forms are given. Experimental spectra from fission with thermal neutrons are presented. The emphasis was on the fission induced by fast or spontaneous neutrons. The agreement of the different theoretical curves and the experimental spectra is discussed. (tr-auth)

13307 (HW-SA-3769) RADIONUCLIDE GENERATION CALCULATIONS. van Tuyl, H. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Oct. 20, 1964. 16p. Dep. CFSTI.

Equations for transformations by radioactive decay and neutron capture are derived from the usual exponential formulation. The results are expressed in a series form, or a combined series and exponential form. A recursion relation is also developed. Examples are given to demonstrate that no single formulation is universally best, but that one or more of the equations may be applied to obtain accurate evaluations for any chain length and any combination of transformation constants. The applicability and limitations of each equation are discussed. Applications are described with particular attention being devoted to "feedback" systems in which the rate of production of a nuclide depends on the quantity of its daughters. A cyclic feedback system can be evaluated by treating it as a linear system with an unlimited number of terms. (auth)

13308 (KFK-830) ELECTRON CAPTURE RATIOS. Behrens, H.; Buehring, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). July 1968. 6p. (CONF-680703-2). Dep.

From International Conference on Electron Capture and Higher Order Processes in Nuclear Decay, Debrecen, Hungary.

Electron capture ratios (L/K and M/L) were calculated for nuclei with a wide range of Z values. The one-electron Dirac radial equations were solved numerically for a potential corresponding to an extended (uniform) nuclear charge distribution that is screened by atomic electrons. The screening function was represented by a linear combination of exponential functions, the parameters of which were determined by comparison with Hartree–Fock potentials in the case of low atomic numbers ($Z \leq 36$) and with Thomas–Fermi–Dirac potentials in the case of $Z > 36$. The results were compared with experimental data and with other theoretical predictions. The effects of including Bahcall's atomic overlap and exchange correction were studied. (D.C.W.)

13309 (LAL-1206) ELECTRON SCATTERING FROM p-SHELL NUCLEI. Vinciguerra, D.; Stovall, T. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jan. 1969. 42p. Dep.

Existing high-energy electron-scattering data on p-shell nuclei are analyzed using nuclear wave functions obtained by extending the Nilsson model to include in the single-particle orbitals admixtures from higher major shells. Good fits are found for the electron form factors for elastic and low-lying inelastic scattering. Values of the deformation parameters, the rms charge radii, and the charge quadrupole moments are extracted. (auth)

13310 (OU-LNS-68-12) THE PROGRAM TO CALCULATE THE ISOMERIC CROSS SECTIONS OF (d,p) REACTIONS. Okamura, Hideo (Osaka Univ. (Japan). Lab. of Nuclear Studies). [1968]. 29p. Dep.

The computer program OULNS 68-12 for calculating the cross sections for isomer production by (d,p) reactions is described. The relative probabilities for formation of excited states with different spins and energies in a given residual nucleus are calculated using a method based on the plane-wave Born approximation. The program is written in FORTRAN IV for the HITAC 5020 computer. (D.C.W.)

13311 (PUC-937-346) THE WORKINGMAN'S SHELL MODEL. Notes for Lectures Given at Michigan State University, January 1968. Bertsch, George F. (Princeton Univ., N. J. Palmer Physical Lab.). Nov. 1968. Contract AT(30-1)-937. 41p. Dep. CFSTI.

Some of the techniques used in shell-model calculations are discussed. Basic formulas are derived for calculating nuclear properties with correlation effects. The dependence of the physical matrix elements on correlations is discussed qualitatively. (J.W.R.)

13312 (UCRL-18614) PAIRING IN NUCLEI. Johns, Oliver Davis (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1968. Contract W-7405-eng-48. 203p. Dep. CFSTI. Thesis.

Parts I and II deal with the general problem of adapting the quasiparticle approximation to give satisfactory results in nuclear systems. Part I shows that the projection of correct particle number from the number non-conserving quasiparticle ground state vector can give excellent agreement with exact ground states, when the quasiparticle ground state is first modified by an exponential four, eight, etc., quasiparticle operator. The similarity of this ground state exponential form to that predicted by the quasiboson method leads to Part II, which considers the generalized problem of computing both ground and excited seniority zero 0+ states of nuclei. The results of Part II demonstrate that excellent overlap of boson and exact 0+ states is obtained if the following revisions are made in the quasiboson method: the zero energy boson used to help define the boson ground state should be a certain linear sum of the spurion and its conjugate, and not the spurion alone; the first excited state for moderate to weak pairing potential strength is a two boson state consisting of one zero energy boson and one non-zero energy boson; and the striking failure of the method at subshell closures can be circumvented by slightly altering the average particle number. Part III illustrates the method of exact, number conserving diagonalization of the many body Hamiltonian matrix. This method, which is practical only for non-deformed nuclear systems, is conceptually simpler than the quasiparticle method in which much effort must go into the isolation and correction of approximation produced inaccuracies. (auth)

13313 (UCRL-50484) SEMIEMPIRICAL NEUTRON-INDUCED REACTION CROSS SECTIONS. Alley, W. Edward; Gell, Richard W.; Lessler, Richard M. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 448p. Dep. CFSTI.

This publication is presented for those who wish a quick estimate of neutron reaction cross sections for most stable isotopes from $Z = 1$ to $Z = 83$. The report is a graphical portrayal of cross sections from 0.025 eV to approximately 15 MeV for 796 neutron-induced reactions. Reactions are primarily of the (n,γ), $(n,2n)$, (n,p), (n,α), and (n,pn) types. Some (n,n^*), $(n,3n)$, $(n,2\alpha)$, $(n,\alpha n)$, (n,t), and $(n,^3He)$ reactions are included. Reactions considered are such that parent isotopes are stable and product half-lives are greater than 1 min and less than 10^6 yr. Reactions leading to metastable states are also included where applicable. The reliability of the curves varies considerably. Although some of the cross sections are well-known due to the number of data points available, most cross sections are necessarily approximations, since little or no data are presently available. (auth)

13314 RANGE-EFFECT IN THE GAMMA-NEUTRINO ANGULAR CORRELATION EXPERIMENT. Pratt, T. A. E. C. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Instrum. Methods, 66: 351-2(Dec. 15, 1968).

A method for handling the range-effect in the gamma-neutrino angular correlation experiment is being discussed. The behavior of the modified gamma-neutrino angular correlation expression is studied under different lifetime conditions of the excited state of the recoiling nucleus. (auth)

13315 ELECTRIC MONOPOLE TRANSITIONS IN DEFORMED EVEN-EVEN NUCLEI. Begzhanov, R. B.; Belen'kii, V. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk, Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 44-9(1968). (In Russian).

From an experimental and theoretical study of E0 transitions, it is possible to investigate the nature of the excited states of atomic nuclei and to determine the correct choice of a model describing these states. On comparing the theoretical and experimental data, it is convenient to use the dimensionless ratio X introduced by Rasmussen. This ratio X is taken to be the ratio of the "nuclear probability" of the monopole electric transition $B(E0, i \to i)$ divided by the reduced probability of the E2 transitions. By the use of a rotational-vibrational model and the selection of the proper parameters, theoretical values of X were calculated for E0 transitions between states with spin 0 in ^{150}Sm, ^{152}Sm, ^{154}Gd, ^{156}Gd, ^{168}Yb, ^{178}Hf, ^{230}Th, ^{232}Th, ^{232}U, ^{234}U, ^{236}U, ^{238}Pu, and ^{240}Pu. The rotational-vibrational model gave a better agreement with experimental values of X than other models. Values of $B(E0, i \to i)$ and of $B(E2, i \to f)$ are presented as a function of E_γ and E_β for transitions between excited states with spins ≤ 4. (TTT)

13316 STUDY OF THE CORRELATION OF THE CHARACTERISTICS OF NUCLEAR SPALLATION PRODUCTS WITH THEIR FRAGMENTS. Azimov, S. A.; Karimov, R.; Karimova, R.; Lozhkin, O. V. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk, Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 36-9(1968). (In Russian).

An attempt is made to correlate the parameters of the residual nucleus with the characteristics of the fragments formed in spallation reactions with 25-GeV/c protons. A residual nucleus can be classified by the criterion that $R < 10\ \mu$. A linear correlation is noted between the number of singly- and doubly-charged particles $N_{\alpha p}$ and the range of the strongly ionizing particle at $R < 10\ \mu$ and $R > 10\ \mu$. The effect of the fragment momentum on the momentum of the residual nucleus depends on the relative values of two momenta and their mutual orientation in the center-of-mass system. With the vector sum of momenta at a maximum, the average range of the residual nucleus is $4.30 \pm 0.19\ \mu$. With a minimum vector sum, the average range is $2.25 \pm 0.12\ \mu$. The effect of fragment momentum on the range of the residual nucleus decreases with increasing energy of the incident proton. With incident 660-MeV protons, the fragment momentum has a strong effect on the anisotrophy of the angular distribution of the residual nucleus. The data confirm the view that the spallation fragments are formed before emission of the light particles by evaporation. (TTT)

13317 TO THE THEORY OF PHOTONUCLEAR REACTIONS WITH THE YIELD OF NUCLEON PAIRS. Dzhibuti, R. I. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 8: 892-7(1968). (In Russian).

The photonuclear reaction (γ,np), is considered taking into account two-particle terms in the interaction Hamiltonian of the γ quantum with a nucleus which are due to two-nucleon Majorana exchange forces and depend on the velocity of the Green potential. It is shown that these terms play a considerable role in the process of nuclear photosplitting with a yield of nucleon pairs. (auth)

13318 ON FLUCTUATION MECHANISM FOR EMISSION OF HIGH-ENERGY ^4He NUCLEI IN NUCLEAR SPALLATION PROCESSES. Toktarov, K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 8: 940-1(1968). (In Russian).

The cross section of high-energy ^4He-fragment production in nuclear spallations is estimated on the basis of the fluctuation hypothesis. Comparison with the experimental data shows that the fluctuation approach somewhat overestimates the ^4He production cross section. This is perhaps a result of the neglect of the nucleon interaction in the nucleus when determining the probability of the density fluctuation. (auth)

13319 POLARIZATION EFFECTS IN DIRECT NUCLEAR REACTIONS INVOLVING THREE PARTICLE PRODUCTION. Kolybasov, V. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 898-908(1968). (In Russian).

Polarization effects are considered for the case in which the dominant contribution to the amplitude is given by the pole graph. The polarization and alignment of the residual nucleus as well as the asymmetry in reactions on polarized targets are expressed via polarization of particles involved in the virtual two-particle reaction. The results obtained can be used to identify the mechanism of the reaction and to determine the spin of the residual nucleus. (auth)

13320 MUON CAPTURE AS A PROBE FOR NUCLEAR STRUCTURE. Rho, M. (CEN, Saclay, France). pp 105-13 of Symposia on Theoretical Physics and Mathematics. Vol. 8. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1968.

From Symposia on Theoretical Physics and Mathematics, Madras. See CONF-670123.

The muon capture process as a method for research on nuclear structure is discussed. The formalism for capture by complex nuclei as well as structure-independent weak interactions is described. Experiments which might give a basis for theoretical studies are suggested. (J.W.R.)

13321 ISOSPIN DEPENDENCE OF THE NUCLEAR POTENTIAL. Tolchenkov, D. L. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 8: 1096-1100(Dec. 1968). (In Russian).

The isospin dependence of the nuclear potential was investigated using the experimental data on the reactions $^{42,44,46,48}Ca(^3He,d)$, $^{50}Cr(^3He,d)$, $^{52,54}Cr(d,n)$, $^{54,56}Fe(d,n)$, $^{58}Fe(^3He,d)$, $^{58,60,62,64}Ni(d,n)$, $^{64,66,68}Zn(d,n)$, and $^{112,116,118,122,124}Sn(^3He,d)$. In the final nuclei $^{43,45,47,49}Sc(2p)$ and $^{55,57,59}Co(2p)$, an anomalous value of the shift of the one-particle proton states is found. (auth)

13322 ISOBARIC SPIN AND DIPOLE STATES IN NUCLEI. Brink, David M.; Peierls, Rudolf E. (Oxford Univ.). Comments Nucl. Particle Phys., 2: 180-1(Nov.-Dec. 1968).

The role of isobaric spin in dipole states is discussed. It is suggested that the two components of the dipole state in heavy nuclei may not be observed since the T_0 state should carry much more strength than the $T_0 + 1$ state. (J.W.R.)

13323 MICROSCOPIC APPROACH TO NUCLEAR REACTIONS. Weidenmueller, Hans A. (Yale Univ., New Haven. Institut fuer Theoretische Physik, Heidelberg). Comments Nucl. Particle Phys., 2: 182-7(Nov.-Dec. 1968).

The shell-model microscopic approach to nuclear reactions is discussed. Approximation procedures used in constructing the Hamiltonian, and the inherent properties of the shell-model Hamiltonian are discussed. (J.W.R.)

13324 DIFFRACTION THEORY OF STRIPPING REACTIONS. Shebeko, A. V.; Inopin, E. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Yadern. Fiz., 8: 1142-50(Dec. 1968). (In Russian).

Analytical expressions for the amplitude and differential cross section of the stripping reaction are obtained on the basis of a method using the partial-wave expansion. The method proposed can be applied to describe other direct reactions. (auth)

13325 EFFECT OF DISCRETE STRUCTURE OF ONE-PARTICLE SPECTRUM ON THERMODYNAMICAL FUNCTIONS OF NUCLEI. Ignatyuk, A. V.; Shubin, Yu. N. (Physical-Power Engineering Inst., Obninsk, USSR). Yadern. Fiz., 8: 1135-41 (Dec. 1968). (In Russian).

The effect of the discrete structure of the one-particle spectrum on the behavior of thermodynamical functions of excited nuclear states is investigated both with and without an account of pair correlations. Calculations were performed for the one-particle spectrum of the Nilsson's model without use of asymptotic integral expressions. The results of the calculations describe rather well the experimental data on the density of excited states of atomic nuclei over a wide range of the mass number. (auth)

13326 RESIDUAL INTERACTION IN NUCLEUS. Band, I. M.; Guman, V. N.; Sliv, L. A.; Kharitonov, Yu. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 8: 1118-27(Dec. 1968). (In Russian).

The range of r_0 of residual central forces in the nucleus is considered. It is shown that the most sensitive to the range r_0 are splittings of two-particle configurations and binding energies of n particles on the level j. It follows from the analysis of corresponding data on the nuclei in the region of Pb that the range of central forces is $r_0 = 1.8$ to 2.0 fm. Singularities of splittings of two-particle configurations affected by tensor forces allow one to determine their contributions to the binding energy of levels with spins J = 0 and J = 1. A possible kind of dependence of residual interaction on the density of particles in the nucleus is discussed. (auth)

13327 THE LINKED-CLUSTER EXPANSION FOR THE TRANSITION AMPLITUDE FOR DEUTERON STRIPPING REACTIONS. Junkin, W. F.; Villars, F. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.), 51: 68-99(Jan. 1969).

The linked-cluster expansion for the transition amplitude for deuteron stripping reactions is derived. It is shown that this amplitude can be expressed (exactly) as a matrix element of an effective neutron-proton interaction between appropriate two-nucleon states. A linked-cluster expansion of this effective interaction is given. The initial state is a deuteron scattering state in an effective potential, for which a linked-cluster expansion has been given previously. The final state is the product of a bound Hartree–Fock state for the stripped nucleon and a continuum state in an effective optical potential for the outgoing nucleon. The leading terms in this expression for the transition amplitude are compared with conventionally used approximate expressions for the stripping reactions (such as the direct interaction approximation) and certain questions, such as the theoretical interpretation of the spectroscopic factor and the single particle energy of the captured nucleon, are examined. (auth)

13328 VARIATIONAL BUILDUP OF NUCLEAR SHELL MODEL BASES. Sebe, T.; Nachamkin, J. (Chalk River Nuclear Labs., Can.). Ann. Phys. (N. Y.), 51: 100-23(Jan. 1969).

A method is proposed for accurately calculating a few of the low-lying states belonging to each nuclear spin within the shell model. A properly chosen initial vector is operated upon iteratively, generating a basis in which the Hamiltonian matrix is tridiagonal. The process may be halted when low-lying eigenvalues, up to a preset number, have been determined to a required accuracy, implying a truncation of the complete vector space. Simple formulas are given for the errors induced by this truncation, both for eigenvalues and eigenfunctions. Illustrative calculations are shown for the 0^+ (T = 0), 2^+ (T = 0), 4^+ (T = 0), 2^+ (T = 1), and 3^+ (T = 1) states of ^{20}Ne. By taking the leading SU_3 states as initial vectors, quite accurate low-lying eigenvalues and eigenfunctions are obtained with a small-sized truncation space. The T = 0 states mentioned allow a three dimensional truncation to yield lowest eigenvalues with an error of less than 0.05 MeV as well as corresponding eigenfunctions having an overlap of greater than 99.5% with the exact ones. Special eigenvalue-problem techniques are discussed. (auth)

13329 NUMBER-CONSERVING APPROACH TO SPHERICAL NUCLEI. Salusti, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Tesei, A. Nuovo Cim., Lett., 1: 50-2 (Jan. 1, 1969).

A method is proposed for eliminating spurious states arising in the particle-hole treatment of the residual interaction in the nuclear shell model. (J.W.R.)

13330 REGGE TRAJECTORY FOR NUCLEON–NUCLEUS SCATTERING. Iwao, Syurei; Kawakami, Akira (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 1046-59(Nov. 1968).

The theory of complex angular momentum for nucleon-nucleus scattering is developed in relation to the R-matrix theory of nuclear reactions. As a particular example, the Briet–Wigner multilevel formula in terms of Regge parameters is discussed in a suitable form for practical analysis. The theory is applied to the s- and p-wave elastic proton and neutron scatterings by ^{14}C and ^{14}N through the ^{15}N compound states. The complication arising near the resonance energy reflects in the Regge trajectory which seems to be a convenient tool for analyzing the properties of the nuclei. The trajectory is represented by a curve on a unit circle in our representation so that the relative strength of the nucleon-nucleus interaction can be read from the residue function for the various reactions. A Chew–Frautschi plot for the proton trajectory obtained from spin $\frac{1}{2}$ and $\frac{5}{2}$ states suggests that the nucleon-nucleus potential for the overall range of energies may be of the square-well type in a global sense, but the Regge trajectory near the resonance region is much more complicated and is possibly a combination of Yukawa, square-well, and/or some other potentials. (auth)

13331 TO THE THEORY OF RADIATIVE CAPTURE AND SCATTERING OF SLOW PIONS BY NUCLEI. Akhiezer, A. I.; Akhiezer, I. A. (Kharkov State Univ.). Yadern. Fiz., 8: 1029-41(Nov. 1968). (In Russian).

The interaction of slow pions with nuclei was investigated. The scattering of slow pions with and without changing their charge was considered as well as the radiative capture of slow pions and the pion photoproduction near the threshold. The cross sections of the processes studied were calculated in terms of the Fermi-liquid model. It is shown that together with the plateau caused by the interaction of pions with individual nucleons, the cross sections must contain prominent maxima due to the presence of collective excitations analogous to the zero sound in the Fermi liquid. Radiative capture of slow neutrons can be used for experimental checks of the existence of bound spin-isospin oscillations in nuclei. By analogy, the slow pion scattering can be used to investigate the density waves and the isospin sound. (auth)

13332 EFFECT OF INTERNAL DEUTRON STRUCTURE ON INELASTIC DIFFRACTION SCATTERING. Berezhnoi, Yu. A.; Evlanov, M. V. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 8: 1151-5(Dec. 1968). (In Russian).

Inelastic deuteron diffraction scattering accompanied by the excitation of collective states in nuclei is considered. It is shown that at the deutron scattering the phase shift rule for differential cross sections of inelastic scattering is fulfilled as in the case of a point particle. (auth)

13333 FORMATION OF PEAKS IN NUCLEAR REACTIONS. de Alba, E.; Jaidar, A.; Martinex Negrete, M. A. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 17: 143-61(1968). (In Spanish).

The number of particles versus energy distribution that is obtained during the observation of a nuclear reaction is explained in terms of small-angle scattering of the incoming particle against the target material. (auth)

13334 EFFECT OF SHORT-RANGE CORRELATION IN DEUTERON ON (d,p) STRIPPING REACTION. Gyarmati, B. (Inst. of Nuclear Research, Debrecen, Hungary); Zimanyi, J. Phys. Lett., 28B: 363-4(Jan. 6, 1969).

The effect of the repulsive core on (d,p) stripping is shown to be negligible in DWBA. (auth)

13335 EFFECTIVE TWO BODY FORCES IN NUCLEI AND GAUGE INVARIANCE. Belyaev, S. T. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett., 28B: 365-7(Jan. 6, 1969).

The consequences of the conservation of nucleon current, considering it to be of one-particle structure, are discussed. (auth)

13336 MULTI-STEP STRIPPING ON DEFORMED NUCLEI. Lukyanov, V. K.; Petkov, I. Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 28B: 368-71(Jan. 6, 1969).

The expression for the stripping cross section on deformed nuclei was analyzed. Using the diffraction approximation, the multi-step character of the (d,p) stripping reaction was revealed. As an example the reaction ^{24}Mg(d,p)^{25}Mg with transition to the levels $5/2^+$ (g.s.) and $7/2^+$ (1.61 MeV) was considered. (auth)

13337 APPLICATION OF THE K-MATRIX THEORY OF NUCLEAR REACTIONS TO A SOLUBLE MODEL. Mekjian, A. (Univ. of Maryland, College Park). Phys. Lett., 28B: 375-7 (Jan. 6, 1969). (ORO-3765-13).

The zero-range coupled channel model of nuclear reactions due to Tobocman and Garside is solved using the K-matrix theory in a projection formalism to provide insight into the significance of couplings between discrete states through continuum channels. The convergence of the theory is studied. (auth)

13338 SEPARABILITY OF THE NUCLEAR RESIDUAL TWO-BODY INTERACTION. Shah, J. A. (Univ., Frankfurt am Main); Huber, M. G.; Danos, M. Phys. Lett., 28B: 381-3(Jan. 6, 1969).

The giant resonance of ^{16}O was computed in the one particle-one hole approximation with a finite-range two-body force and a separable force constructed from it in a systematic fashion. For this case a separable force, which corresponds to the exchange of a single value of the momentum reproduces with a very high accuracy the results obtained with the complete force. (auth)

13339 NEUTRON SINGLE PARTICLE LEVELS IN A WOOD-SAXON POTENTIAL. Takeuchi, K.; Moldauer, P. A. (Argonne National Lab., Ill.). Phys. Lett., 28B: 384-6(Jan. 6, 1969).

Neutron single particle levels in the Wood–Saxon well with a Thomas spin-orbit term are calculated. The A-dependence of levels, their ordering, and spin-doublet spacings are in good agreement with experiment. (auth)

13340 SPECTROSCOPIC FACTORS AND SINGLE PARTICLE FORM FACTORS. Clement, C. F. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 28B: 395-7(Jan. 6, 1969).

Exact equations are obtained which relate single-particle overlap functions and spectroscopic factors. Truncation of these equations leads to a theorem relating the sum of the spectroscopic factors to the number of underlying single-particle bound states. (auth)

13341 HARTREE–FOCK EQUATIONS FOR SEPARATION ENERGIES AND SINGLE PARTICLE STATES IN NUCLEI. Clement, C. F. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 28B: 398-400(Jan. 6, 1969).

It is shown that the underlying single-particle bound states defined in a previous paper satisfy coupled equations which have the form of generalized Hartree–Fock equations. (auth)

13342 DO K^- MESON ABSORPTIONS BY HEAVY NUCLEI IMPLY A NEUTRON HALO? Bugg, W. M. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Condo, G. T.; Cohn, H. O.; Hill, R. D. Nucl. Phys., A124: 212-16(1969).

Examination of the available experimental evidence on mesic atoms suggests that the nuclear capture of K^- mesons may well be less peripheral than is commonly supposed. This conclusion tends to vitiate recent results, obtained in a study of K^- meson nuclear absorptions, that indicate a neutron halo on the surface of heavy nuclei. (auth)

13343 ACCURATE CALCULATION OF THE REACTION MATRIX IN LIGHT NUCLEI AND IN NUCLEAR MATTER. Kallio, A.; Day, B. D. (Argonne National Lab., Ill.). Nucl. Phys., A124: 177-98(1969).

A method for calculating the Brueckner reaction matrix in the oscillator representation, which was outlined in an earlier letter, is explained in detail. The basic equations are derived and solved numerically. It is shown how the t-matrix elements thus obtained can be used to calculate certain higher-order diagrams for the energy and r.m.s. radius; and numerical results are presented. Finally, the method is applied to infinite nuclear matter, and some numerical results are given for the Reid hard-core and soft-core potentials. (auth)

13344 ANALYSIS OF THE POTENTIAL MODEL NUCLEON–NUCLEON BREMSSTRAHLUNG. Liou, M. K.; Cho, K. S. (Univ. of Manitoba, Winnipeg). Nucl. Phys., A124: 85-96(1969).

A method of deriving an analytic expression for the rescattering amplitude $M_{2\mu}$ is presented. It was assumed that nucleons interact via a two-body static potential. It is shown that $M_{2\mu}$ can be written as $M_{2\mu} = M_{c\mu} + (\frac{1}{2} M_R + M_W)_\mu$. Amplitudes $M_{c\mu}$ and $M_{R\mu}$ vanish in the center-of-mass frame for the proton-proton case, while only $M_{c\mu}$ vanishes for the neutron-proton case. Together with the single scattering amplitude $M_{1\mu}$, it is shown that $K_\mu(M_{1\mu} + M_{2\mu}) = K_\mu(\frac{1}{2} M_R + M_W)_\mu \neq 0$. For low energies, in the center-of-mass frame, the amplitude $M_{W\mu}$ is negligible for the proton-proton case, while both $M_{R\mu}$ and $M_{W\mu}$ can not be neglected for the neutron-proton case. In the lab frame, the amplitude $M_{c\mu}$ predominates for the proton-proton case, while $M_{c\mu}$, $M_{R\mu}$, and $M_{W\mu}$ are important for the neutron-proton case. In the proton-proton case, the amplitude $M_{2\mu}$ does satisfy the assumption of the low-energy theorem, but it is not conclusive for the neutron-proton case. Non-coplanar cross sections for the proton-proton bremsstrahlung process are calculated using the Hamada–Johnston potential. Results are in agreement with experimental data. (auth)

13345 RELATION BETWEEN VARIOUS METHODS USED IN CALCULATING NUCLEAR REACTION MATRIX ELEMENTS. Mavromatis, H. A. (American Univ. of Beirut); Sanderson, E. A.; Jackson, A. J. Nucl. Phys., A124: 1-14(1969).

Various methods for calculating nuclear reaction matrix elements from phase shifts are examined. Calculations are made for the singlet S channel using these various methods and the results are compared. It is shown that a close analogy exists between the auxiliary potential method of calculating nuclear reaction matrix elements and the Scott–Moszkowski separation method. (auth)

13346 HIGHER-ORDER CORRECTIONS TO THE RIGID ROTATOR LAW I(I +1). Gupta, R. K. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 47: 299-307(Feb. 1, 1969).

A two-parameter model is developed for the rotational states in deformed even–even nuclei by assuming that the nuclear moment of inertia is modified due to centrifugal stretching and that the resulting change in shape (i.e., the β-vibrations) is balanced by harmonic restoring forces. The rotational energy expression is obtained in the form of an asymptotic series which permitted an investigation of the conditions for the eventual breakdown of (macroscopic) rotational structure at high angular momentum and also to distinguish between "soft" rotator and hard rotator. (auth) (Canada)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 11704, 12116, 13441, and 13444.

13347 (AEC-tr-6956) WUERGASSEN NUCLEAR POWER PLANT: INFORMATORY REPORT. (Allgemeine Elektricitaets-Gesellschaft AEG-Telefunken, Frankfurt (West Germany)). Translation of a German report. 30p. Dep. CFSTI.

A general survey of the site of the Wuergassen Power Reactor is presented. (D.C.C.)

13348 (AEC-tr-6995) EVOLUTION OF THE FUEL-ENERGY BALANCE OF THE USSR DURING 50 YEARS OF SOVIET RULE. Nekrasov, A. M.; Pavlenko, A. S.; Shteingauz, E. O. Translation of Paper No. 12 from the 7th World Power Conference, Moscow, 20–24 August 1968. 17p. (CONF-680829-4). Dep. CFSTI.

The nature of the major stages in development of the fuel-energy balance in the USSR during the past fifty years is described. A breakout of the production and consumption of fuel-energy resources of pre-revolutionary Russia and in the USSR in the middle 60's is given. Analysis is made of the basic trends in development of the fuel-energy economy of the USSR and their concrete interpretation at the various stages of economic development, the different degrees of investigation of the energy resources, the changes in technology and economics of extraction, and transport and utilization of fuel and energy. Special attention is given to the effect of electrification on the pattern of fuel-energy balance and increase in efficiency of fuel and energy utilization in various branches of the national economy. Calculations are presented regarding not only fiscal fuel and energy consumption, but also the effect of nominal useful consumption of all forms of energy. (auth)

13349 (AEC-tr-6996) USSR POWER RESOURCES. Voznesenskii, A. N.; Zenkis, Ya. S.; Mel'nikov, N. V.; Sidorenko, A. V.; Shelest, L. N. Translation of Paper No. 33 from the 7th World Power Conference, Moscow, 20–24 August 1968. 22p. (CONF-680829-5). Dep. CFSTI.

A description of the power resources available to U.S.S.R. is presented. The importance of nuclear power plants in the overall power production requirements is described. (D.C.C.)

13350 (AERE-R-5773(Vol.4), pp 1003-44) SHIELDING EXPERIMENTS IN THE START-UP OF THE EDF-1, -2, -3 REACTORS IN COMPARISON WITH THE THEORETICAL FORMULAE. Brisbois, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Montbeyre, R.; Rafalovitch, A. (Electricite de France, Clamart); Sonnet, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

Shielding experiments on power reactors are aimed at testing the efficiency of the shielding in position and testing the validity of the theoretical formulae used. On EDF1, EDF2, and EDF3 these experiments were carried out largely during cold tests and low-power tests during the start-up of the reactors. The main points investigated were: the Wigner effect in the steel shell of EDF1; the heating of the upper part of the prestressed concrete shell in EDF3; and the neutron fluxes at the ionization chamber positions. The theoretical formulas used arise from various methods, from two-group diffusion theory to the Monte Carlo method. The constants used in the codes were determined by preliminary experiments on models. There is, generally speaking, satisfactory agreement between the theoretical formulas and the experimental results. This agreement is due to the fact that the methods of calculation used are specific to the problem and have been tested by numerous experiments on models of various geometries. 17 references. (auth)

13351 (AERE-R-5773(Vol.4), pp 1069-96) SHIELDING PERFORMANCE OF MAGNOX POWER STATIONS IN THE LIGHT OF OPERATING EXPERIENCE. Pugh, I. G.; Tattersall, D. (Central Electricity Generating Board, London (England)); Wilkinson, K. (Nuclear Power Group, Knutsford (England)); Stewart, R. A. (Atomic Power Constructions Ltd., Sutton (England)); Spooner, J. B. (Nuclear Design and Construction Ltd., Whetstone (England)).

In 1956 when the first CEGB reactors were being designed, methods of calculation for the shielding of power reactors were in the formulative stage. As the U. K. power program developed, these methods were improved to further the optimization of shielding designs. In order to demonstrate this progress the history of several types of calculations is described. Predictions are compared with measurements made during commissioning and operation of the reactors. Most of the measurements were made on the Berkeley and Bradwell stations, as these were the first to be commissioned. Their satisfactory shielding performance showed that special shielding measurements were not necessary for other similar stations of this type. Subsequent routine health physics measurements have shown that this confidence was justified. Aspects of shielding considered are the top and side shields of reactors, activation of reactor main coolant and shield cooling air, streaming from the reactor into main coolant ducts and into the fueling machines together with the shielding of the fueling machines. 12 references. (auth)

13352 (AERE-R-5773(Vol.4), pp 1124-51) THE SHIELD TESTING PROGRAM FOR THE ENRICO FERMI FAST BREEDER REACTOR. Beaudry, Richard J. (Atomic Power Development Associates, Inc., Detroit, Mich.).

Extensive nuclear measurements made in the shield system of the Fermi reactor at power levels up to 100 MW(t) are summarized. Included were measurements on the various radiation levels throughout the plant, the radioactivity levels of coolant and cover gas, and the efficiency of the as-built shields. Comparisons between calculated and measured parameters in the shielding system are in good agreement with the exception of lower than anticipated radiation streaming through shield penetrations. 13 references. (H.D.R.)

13353 (AERE-R-5773(Vol.4), pp 1175-1204) SHIELDING PROBLEMS ASSOCIATED WITH COMMERCIAL A.G.R. POWER STATIONS. Stewart, R. A. (Atomic Power Constructions Ltd., Sutton (England)); Tayler, J. M. (Nuclear Design and Construction Ltd., Whetstone (England)); Youell, F. P. (Nuclear Power Group, Knutsford (England)).

The shielding in the current designs of A.G.R. power stations is examined, and calculational techniques used to solve the problems that have arisen, are described. 8 references. (auth)

13354 (AERE-R-5773(Vol.4), pp 1205-46) SHIELDING STUDIES FOR THE PUBLIC SERVICE COMPANY OF COLORADO HTGR. Engholm, B. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Radiation-shielding methods used in the design of a 330-MW(e) HTGR power plant are described. Neutron fluxes outside the reactor core are calculated by a combination of the DTF-IV transport code and the GAZE diffusion code. For preliminary shielding calculations and parametric studies, a more rapid neutron-shielding code is available, based in part on the Spinney method. Gamma calculations are handled either by transport theory or by General Atomic's new PATH code, which is based on exponential attenuation from source point to dose point, adjusted by appropriate buildup factors. Duct streaming is treated by a variety of methods, including Monte Carlo techniques and a combination albedo and graphical approach. The MUSCAT code has been written to treat multiple scattering of particles in spherical or cylindrical annuli, such as the space between the reactor and pressure vessel. An extensive calculational program is under way to generate γ buildup factors for homogeneous materials not considered by Goldstein and Wilkins and for heterogeneous media such as alternating layers. Exploratory transport-theory results agree well with moments-method data and experimental measurements. Initial shielding measurements performed on the Peach Bottom HTGR are in satisfactory agreement with calculated values. 35 references. (auth)

13355 (APDA-CFE-25) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, SEPTEMBER 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Dec. 1968. Contract AT(11-1)-865. 32p. Dep. CFSTI.

It was demonstrated in tests that the arc-melt tool can be satisfactorily articulated, and can melt Zr screwheads in a 350 F Ar and Na vapor environment such as will be experienced in the reactor. The arc-melt tool is to be used to melt the fastening screwheads to free the Zr segments from the conical flow guide in the reactor inlet plenum. The new electrohydraulic control system for the spine-type manipulator was assembled and made ready for testing in the reactor mock-up. A new football-shaped housing for the retrival-device gripper is being constructed of aluminum. It was demonstrated in the mock-up that an undistorted Zr segment could be removed through the 14-inch inlet line by means of the object-retrieval device and associated gripper, even though it is slightly wider than the shield ring in the 14-inch line.

Thirty-five core subassemblies were relocated to open up core positions for insertion of tools and viewing equipment for the segment removal program. The steam generators were operationally tested to determine the integrity of the water tubes. (auth)

13356 (CONF-680601-45) LARGE GAS-COOLED REACTORS FOR U. S. CENTRAL STATIONS. Shiells, D. A. (Bechtel Corp., San Francisco, Calif.); Brierley, G. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). [1967]. 27p.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

An appraisal in depth of the applicability of the AGR for power stations in the U. S. was made in two separate studies (768 and 1015 MW(e)). Based upon the analyses and investigations conducted, the following conclusions are drawn. Power generation costs would be competitive with those systems currently being ordered in the U. S. programs. The stations could be designed and constructed within the same period as other nuclear stations. Thermal pollution from the station cooling water would be as low as from a modern fossil-fuelled station. On-line refuelling permits highly flexible station loading schedules to meet system demands without regard to scheduled core refuelling outages. Operating and maintenance requirements are comparable to large U. S. nuclear stations. Components used in the AGR station can be manufactured in the U. S. without extensive development. The reactor has several characteristics which enhance reliability and safety. (UK)

13357 (DOCKET-5029-1) [YANKEE ATOMIC POWER PLANT]. [Preliminary Safety Analysis Report], Amendment 52. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 2, 1967. 24p. Dep. CFSTI.

Design of the cruciform control rods for the Yankee Power Reactor is discussed; drawings are included. Thermal and nuclear parameters of core VI are tabulated; hot channel factor variations are shown graphically. Design drawings for the pressure control relief system, sampling system, and vent and drain systems are included. (M.L.S.)

13358 (DOCKET-50255-11) PALISADES PLANT. Final Safety Analysis Report, Amendment 9, Vol. 2. (Consumers Power Co., Jackson, Mich.). Nov. 1, 1968. 325p. Dep. CFSTI.

Information on Palisades Power Reactor is given on the following broad topics: Instrumentation and Control; Electrical Systems; Auxiliary Systems; Steam and Power Conversion Systems; Radioactive Waste and Radiation Protection; Conduct of Operations; and Initial Tests and Operations. (M.L.S.)

13359 (DOCKET-50255-12) PALISADES PLANT. Final Safety Analysis Report, Amendment 9, Vol. 3. (Consumers Power Co., Jackson, Mich.). Nov. 1, 1968. 401p. Dep. CFSTI.

Safety Analyses of the Palisades Power Reactor are detailed. Design bases for structures, systems and equipment are given; containment structure design bases are listed. Development tests for hydraulic effects, fuel bowing effects, and reactor vessel flow tests are discussed. Meteorology data on the Palisades site are given. The quality assurance program is outlined. The report on the studies for the concrete containment vessel is included. Strain instrumentation for the containment structure is described. Cracking of the containment liner plate welds is discussed. Palisades design is compared with AEC General Design Criteria. (M.L.S.)

13360 (DOCKET-50271-4) [VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VERMONT]. [Plant Design and Analysis Report], Amendment 1. (Vermont Yankee Nuclear Power Corp., Rutland). Jan. 10, 1967. 5p. Dep. CFSTI.

A revised list of the Directors of the Vermont Yankee Nuclear Power Corporation, owners of Vermont Yankee Power Reactor, is given. (M.L.S.)

13361 (DOCKET-50286-14) INDIAN POINT [NUCLEAR GENERATING] UNIT NO. 3. [Preliminary Safety Analysis Report], Amendment 11, Suppl. 10. (Consolidated Edison Co. of New York, Inc., New York). Jan. 6, 1969. 7p. Dep. CFSTI.

Revised information on flood analyses for the Indian Point Power Reactor, Unit 3 site is included. (M.L.S.)

13362 (DOCKET-50312-8) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Suppl. 1. (Sacramento Municipal Utility District, Calif.). Dec. 1968. 107p. Dep. CFSTI.

The design parameters for increasing the diameter of the containment building for Rancho Seco Power Reactor, Unit 1 are given; revised containment building design criteria are included. New fuel handling methods and structural design bases are described. (M.L.S.)

13363 (DOCKET-50324-6) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3, Suppl. 2. (Carolina Power and Light Co., Raleigh, N. C.). Jan. 17, 1969. 188p. (DOCKET-50325-6). Dep. CFSTI.

Tornado wind loadings for the plant stack and control building for Brunswick Power Reactor, Units 1 and 2, are given. Detailed design data and analyses are given for the containment structure; seismic design is discussed. Surface stresses for the containment structure liner are given as a function of structure diameter. Concrete and reinforcement analyses are detailed. Containment liner design is discussed; methods for liner anchorage are described. Containment penetration and large opening design are analyzed. Methods for emergency reactor shutdown are described. Stability of the offsite electrical supply is evaluated. Composition of stack effluent is tabulated as a function of time. The pressure suppression containment system is discussed. (M.L.S.)

13364 (DOCKET-50329-1) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 1. (Consumers Power Co., Jackson, Mich.). Oct. 30, 1968. 881p. (DOCKET-50330-1). Dep. CFSTI.

Information on the Midland Power Reactor, Units 1 and 2, is given on the following broad topics: Introduction and Summary with appendices on a glossary of terms, quality assurance program, and principal design criteria; Site and Environment with appendices including enviromental study meteorology, surface water hydrology, and planning emergency shutdown procedures; Reactor with appendix detailing modal analysis of xenon-induced oscillations; and Reactor Coolant System. (M.L.S.)

13365 (DOCKET-50329-2) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Vol. 2. (Consumers Power Co., Jackson, Mich.). Oct. 30, 1968. 871p. (DOCKET-50330-2). Dep. CFSTI.

Information on Midland Power Reactor, Units 1 and 2, is given on the following broad topics: Reactor Building and Structures with appendices including design bases for structures, systems, equipment, reactor building pressure tests, mechanical splicing of reinforcing bar, load factors and load combinations, yield reduction factors, reactor building structural analysis, quality control procedures for field welding of liner plate; Engineered Safeguards; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Waste; Conduct of Operations; and Safety Analysis. (M.L.S.)

13366 (DOCKET-50329-3) [MIDLAND PLANT, UNITS 1 AND 2]. [Preliminary Safety Analysis Report], Supplement to Section 2C. (Consumers Power Co., Jackson, Mich.). Jan. 7, 1969. 40p. (DOCKET-50330-3). Dep. CFSTI.

The detailed site emergency plan for the Midland Power Reactor, Units 1 and 2, is given. This prescribes immediate action to be taken by plant personnel to minimize radiation exposure to persons within the exclusion area, including Dow Chemical Company personnel, and outside the exclusion area. (M.L.S.)

13367 (EIR-141) PRINCIPAL CONSIDERATIONS IN THE DESIGN OF GAS COOLED FAST REACTORS WITH DIRECT CYCLE GAS TURBINES. Lys, L. A.; Broido, J. H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Sept. 1968. 17p. (CONF-681008-4). Dep.

From Symposium on Advanced and High Temperature Gas-Cooled Reactors, Juelich, Germany.

The development of an economic closed cycle gas turbine system to be used with a gas-cooled fast reactor is described. The thermodynamic parameters of the system are analyzed. Safety and economic aspects are discussed. (D.C.C.)

13368 (GA-9080) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR, POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending, October 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 27, 1968. Contract AT-(04-3)-314. 42p. Dep. CFSTI.

Operations in the Peach Bottom Power Reactor Unit 1 are described for August to October 1968. Power histories for this period are given. Maintenance required is described. The performance of the He purification system is analyzed. Accumulations of ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{89}Kr, ^{133}Xe, ^{135}Xe, and ^{138}Xe are plotted in relation to burnup. (D.C.C.)

13369 (JPRS-46747) DEVELOPMENT AND CONSTRUCTION OF ATOMIC POWER PLANTS IN THE USSR. Translation of two Russian-language Monographs. 25p.

Separate abstracts are included for the 2 papers presented.

The general growth of nuclear power plant development in the U.S.S.R. is discussed. Design characteristics of the BN-350 and BN-600 reactors are presented. (D.C.C.)

For abstracts of individual papers see: 13370 and 13371.

13370 (JPRS-46747, pp 1-13) DEVELOPMENT OF ATOMIC POWER PLANTS WITH FAST BREEDER REACTORS IN THE SOVIET UNION. Leypunskii, A. I.; Afrikantov, I. I.; Kazachkovskii, O. D.; Orlov, V. V.; Pinkhasik, M. S.; Troyanov, M. F. Translated from paper 190 of Seventh World Power Conference, Section C$_3$, August 20-24, 1968, Moscow. (CONF-680829-3).

The development of fast breeder reactors for large-scale nuclear power production in the U.S.S.R. is described. Design characteristics of the BN-350 and BN-600 reactors are presented. (D.C.C.)

13371 (JPRS-46747, pp 14-24) THE ATOMIC POWER STATION BN-600. Leypunskii, A. I.; Afrikantov, I. I.; Golovnin, I. S.; Mitenkov, F. M.; Orlov, V. V.; Pinkhasik, M. S.; Rineskii, A. A.; Stekol'nikov, V. V.; Troyanov, M. F.; Shiryaev, V. I. Translated from paper 191 of Seventh World Power Conference, Section C$_3$, August 20-24, 1968, Moscow. (CONF-680829-6).

Design specifications and characteristics of the BN-600 Reactor are presented. 8 references. (D.C.C.)

13372 (WAPD-294) SHIPPINGPORT OPERATIONS DURING PWR CORE 1 DEPLETION, DECEMBER 1957-FEBRUARY 1964. Dressler, R. T.; Kemmet, L. H. (eds.) (Bettis Atomic Power Lab., Pittsburgh, Pa.); O'Hara, R. D. (ed.) (Duquesne Light Co., Pittsburgh, Pa.). Dec. 1968. Contracts AT(11-1)-Gen-14; AT(11-1)-292. 124p. Dep. CFSTI.

Shippingport Atomic Power Station Core 1 lifetime experience is presented. Significant nuclear aspects are discussed; these include operating experience (e.g., highlights, incidents, maintenance, performance, refueling), reactor and reactor plant experience (e.g., accumulative reactor physics performance and thermal experience, reactor plant and component experience, and electrical system experience and modifications), and radioactive contamination and waste disposal. The performance information, and results obtained from Core 1 life were of direct use in the operation of Core 1, and were applied in the design of the advanced, Core 2, seed-blanket reactor. 23 references. (auth)

13373 CUTTING CONSTRUCTION COSTS AT HARTLEPOOL 1250MW NUCLEAR STATION. Engineer, 226: 823-4(Nov. 29, 1968).

The design of the twin-reactor 1250 MW(e) Hartlepool nuclear station is outlined, and the main parameters are listed. Construction costs will be reduced by several features, including the use of pod boilers and factory assembly of the gas circulators and other components. The use of circuit-breakers at the generator terminals represents a major change in British practice. (UK)

13374 NUCLEAR POWER PLANTS IN THE AUSTRIAN ELECTRIC INDUSTRY. Kothbauer, Alexander. Elektrotech. Maschinenbau, 85: 193-7(May 1968). (In German).

The overall development of the Austrian energy industry is discussed; energy utilization and production are discussed. The role of nuclear power plants in satisfying projected energy loads is examined. Cost comparisons for nuclear and oil fired plants are considered. (M.L.S.)

13375 ASPECTS ON THE CHOICE OF THE TYPE OF REACTOR FOR THE FIRST AUSTRIAN NUCLEAR POWER PLANT. Gilli, Paul Viktor. Elektrotech. Maschinenbau, 85: 197-209 (May 1968). (In German).

Overall characteristics of the various types of nuclear power plants available on the international market are tabulated; thermal data are tabulated also. Comparisons of these characteristics with the Austrian criteria are made. Fuel, heat transfer, and safety aspects are considered. Investment and capital costs are evaluated; import costs are considered. 31 references. (M.L.S.)

13376 ENERGY SUPPLY IN SWEDEN AND THE ASEA BOILING WATER REACTOR. Ericsson, Ove. Elektrotech. Maschinenbau, 85: 210-12(May 1968). (In German).

The energy supply system for Sweden is described. The efforts of ASEA in the nuclear phase of energy production are summarized; the basic design of the boiling water reactor for Oskarshamn is described. Each of the systems for the Oskarshamn station is discussed briefly. (M.L.S.)

13377 POWER PLANT WITH HIGH-TEMPERATURE GAS-COOLED REACTOR. Fischer, Peter U. Elektrotech. Maschinenbau, 85: 213-16(May 1968). (In German).

The development of commercial high temperature gas cooled reactor systems is summarized. Design characteristics of the Peach Bottom Power Reactor, Unit 1 are tabulated. The Fort St. Vrain Power Reactor, Unit 1 is described; design parameters are given. (M.L.S.)

13378 PRESSURIZED WATER REACTORS. Keller, Wolfgang. Elektrotech. Maschinenbau, 85: 216-19(May 1968). (In German).

The pressurized water reactor is discussed; advantages of this reactor-type are listed. The lower installation costs for Obrigheim are discussed; fuel costs, operational reliability, regulation, and safety are summarized. (M.L.S.)

13379 AEG BOILING-WATER REACTOR. Traube, Klaus. Elektrotech. Maschinenbau, 85: 219-21(May 1968). (In German).

The general development of boiling water reactors (BWR) is reviewed. Operation of a BWR is discussed; advantages are outlined. The various BWR's in Germany are discussed from an administrative standpoint. (M.L.S.)

13380 BRITISH GAS-COOLED REACTOR. Wolff, P. H. W. Elektrotech. Maschinenbau, 85: 222-4(May 1968). (In German).

A tabular summary of British power reactors is given. Development of the Advanced Gas Cooled Reactor (AGR) is discussed. The use of prestressed concrete pressure vessels is described; pressure vessel cross sections are shown. (M.L.S.)

13381 FUEL SUPPLIES AND FUEL CYCLES. Nentwich, Alfred A. Elektrotech. Maschinenbau, 85: 238-50(May 1968). (In German).

The fuel cycle for light water and advanced gas cooled reactors is discussed. The steps in the cycle are listed; each is discussed. Time schedules for each step are given. Fuel data for gas cooled, light water, and heavy water power reactors are tabulated. The fuel supply is discussed. Installed nuclear capacity is tabulated for the western world; U requirements and prices are given. U reserves and production capacity are summarized. UF$_6$ conversion costs are given. The dependence of energy production costs on fuel costs is evaluated. 25 references. (M.L.S.)

13382 NUCLEAR REACTOR PLANT WITH LOAD FLUID FLOW CONTROL. Doroszlai, P. (to Sulzer Brothers Ltd.). Canadian Patent 798,546. Nov. 5, 1968. Priority date May 17, 1963, Switzerland.

Control methods are described for a gas-cooled nuclear power reactor. The plant consists of a reactor, a heat exchanger, means to circulate the coolant in closed cycle through the reactor and the primary side of the heat exchanger, and a variety of sensors to impose necessary control. A pump drives a vaporizable working substance through the secondary side of the heat exchanger to a heat-engine load. There is a means to change the flow of coolant in the cycle in response to changes in the reactor exit coolant temperature, also means to change the flow of working substance through the exchanger in direct response with changes in the exchanger exit coolant temperature. Supplementary means vary the flow of working substance through the exchanger as the reactor neutron flux changes. (F.S.A.)

13383 STADE NUCLEAR POWER STATION. Frewer, H.; Keller, W.; Sparhuber, R. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nucl. Eng. Int., 14: 25-31(Jan. 1969).

The 660 MW(e) PWR power station sited on the Lower Elbe is due for completion in 1972. The design which has evolved from that of the Obrigheim station is described in detail. (UK)

13384 PLANNING THE USE OF WATER FOR COOLING PURPOSES IN POWER STATIONS. Gammon, M. G. Water Res., No. 2, 131-6(Jan. 1968).

Studies were carried out on the environmental effects of heat in discharged cooling water at Bradwell Nuclear Power Station (300 MW) on the unpolluted Blackwater Estuary. The hydrographic investigation showed that the Blackwater Estuary is a vertically homogeneous one and indicated that thorough mixing takes place in the vicinity of the power station. Rapid cooling was shown to take place due to initial mixing in this locality. Layering was found and occurred because the heated discharge was initially of a lesser density than the water in the estuary. Extensive littoral and benthic surveys were carried out and showed no unnatural ecological fluctuations. (UKAEA Info. Bull.)

13385 HEAVY WATER AND HELIUM CIRCUITS OF THE MONTS d'ARREE (EL 4) POWER PLANT. Villiers, H.; Perot, F.; Lagarde, P. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 73, 5-15(Sept.-Oct. 1968). (In French).

The heavy water and helium circuits for the EL-4 are described; schematics are shown. Maintaining heavy water purity is discussed; associated equipment is described. Fabrication and construction of the circuits are summarized. (M.L.S.)

13386 DETERMINATION OF THE THERMAL POWER OF A NUCLEAR REACTOR BY THE THERMODYNAMIC METHOD SIMULTANEOUSLY APPLIED TO THE CARBON DIOXIDE AND WATER-STEAM CIRCUITS. COMPARISON OF RESULTS OBTAINED FOR CHINON 3. Mace, M. P. Bull. Inform. A.T.E.N.

(Ass. Tech. Energ. Nucl.), No. 73, 16-24(Sept.-Oct. 1968). (In French).

A general description of the EDF-3 reactor is given. Application of the enthalpy balance technique to the carbon dioxide and water-steam circuits for determination of power level is discussed. Results of temperature and pressure measurements are tabulated; measurement procedures and equipment are listed. Results from the carbon dioxide and steam circuits are compared. (M.L.S.)

13387 STABILITY INVESTIGATIONS OF THE FINNISH TRANSMISSION SYSTEM WITH CONSIDERATION OF THE FIRST NUCLEAR POWER PLANT. Baumgartner, A. Bull. Ass. Suisse Elec., 59: 733(Aug. 3, 1968). (In French).

There are large distances between production units in the north and points of consumption in the south of Finland, and the Finnish transmission system is consequently open to stability disturbances. The first nuclear power station will carry more than 10% of the production capacity of the entire country, and a study of fluctuations in power must be recalculated in the light of this development. Computer results of stability in stationary and nonstationary use, with sudden removal or short interruption of the nuclear plant output, were calculated, assuming maintenance of the system interconnection between Finland and Sweden. During reduced power requirement periods, it will be necessary to operate the new 400-kV system in parallel with the existing 220-kV system to avoid fluctuations. It is of value to interconnect the north Finnish nuclear plant with Sweden to achieve stability. (BBB)

13388 THE COMMERCIAL SGHWR. Cartwright, H. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 225-31 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The attractiveness of the SGHWR for commercial use is discussed by reference to construction time, component standardization, pressure tubes, plant accessibility, generation system requirements, and containment. The possibilities of a natural UO_2 fueled SGHWR are briefly outlined. (UK)

13389 STEAM GENERATING AND OTHER HEAVY WATER REACTORS. Proceedings of Conference, London, 14–16 May 1968. London, British Nuclear Energy Society, 1968. 242p. (CONF-680538).

The 18 papers, for which separate abstracts were prepared, relate to the SGHWR design and the Winfrith prototype, and to the development of D_2O moderated reactors in Canada, France, Germany, Italy, and Sweden. The opening address and discussions of the papers are included. (UK)

For abstracts of individual papers see: 13388, 13390–13401, 13435–13438, and 13494.

13390 THE SGHWR SYSTEM. Moore, R. V. (United Kingdom Atomic Energy Authority, Risley, Eng.); Holmes, J. E. R. pp 3-10 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

An introduction is given to those papers presented at the conference which related to the Steam Generating Heavy Water Reactor of the UKAEA. The origins are traced of the concept and evolution of the reference design for the Winfrith SGHWR, and of the supporting research and development programmes. The construction of the prototype reactor is reviewed, and possible future steps in achieving the development potential of the system as a commercial power generator are briefly considered. (auth)

13391 ENGINEERING DESIGN OF SGHWRs. Bradley, N.; Dawson, D. J.; Johnson, F. G. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 11-28 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The Winfrith SGHWR and its subsequent development for commercial power stations are described. Sufficient detail is given to provide an introduction to, and overall appreciation of, subsequent detailed papers on particular aspects. (auth)

13392 SGHWR FUEL DESIGN AND MATERIALS. Pickman, D. O. (United Kingdom Atomic Energy Authority, Springfields, Eng.). pp 29-53 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The general design features of the fuel element developed for the Winfrith SGHWR, its operating parameters, and design limits are described. Reference is made to the important differences between this and the fuel element currently under development for a natural UO_2 fueled version of the reactor. Reasons are given for design decisions made during the course of development. Development work on materials, manufacture, fuel pin design and fuel element design, and associated irradiation testing is described. Future trends in fuel element design and materials are considered, and details are given of the extensive experimental fuel program included in the first core of the Winfrith SGHWR, and of the longer term development work. (auth)

13393 NUCLEAR DESIGN OF SGHWRs. Hicks, D. (Atomic Energy Research Establishment, Winfrith, Eng.); Johnstone, I.; O'Dell, F. P. pp 59-68 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The factors influencing the choice of lattice design parameters are reviewed. It is shown, by comparison with experimental data from zero energy assemblies, that the interplay of these parameters is well understood and that, in particular, the coolant void coefficient of reactivity can be predicted accurately. The representation of the complete core of the Winfrith SGHWR is discussed, and it is shown that the validity of the techniques used have been experimentally demonstrated. Finally, the nuclear design aspects of larger SGHWRs, including those designed for operation with natural uranium fuel, are reviewed. (auth)

13394 THERMAL AND HYDRAULIC DESIGN OF SGHWRs. Holmes, J. A. G. (United Kingdom Atomic Energy Authority, Risley, Eng.); Obertelli, J. D.; Roberts, H. A. pp 69-79 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The thermal design features which influence the performance of SGHWR systems are reviewed. These include fuel geometry, fuel channel dimensions, channel power output, coolant flow rate and inlet enthalpy, coolant pressure, and the primary coolant circuit design. An outline is given of the comprehensive set of calculation methods and appropriate computer codes developed to predict a variety of effects, notably fission gas pressures, dryout conditions, coolant flow distribution, and hydrodynamic stability margins. Experimental studies of the channel flow and pressure drop, dryout, and hydraulic stability are summarized. It is shown that predictions can be made of the thermal-hydraulic behavior of SGHWR systems with satisfactory precision, thereby allowing the potential of the concept to be appropriately exploited. (UK)

13395 CONTROL OF SGHWRs. Wray, D. (United Kingdom Atomic Energy Authority, Risley, Eng.); Butterfield, M. H.; McMillan, R. N. H. pp 81-94 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The bases for control of steam generating heavy water reactor stations are described, and some detail is given of the system adopted for the Winfrith SGHWR. The basic dynamic properties of the SGHWR system are discussed in terms of possible control actions, the practical requirements for normal regulation, and protection against fault conditions. A brief description of the methods used for system design and of the SGHWR simulator is given; simulation proved useful not only in control design but also in training operators. A description is provided of the station power, drum pressure, and drum level controls on the Winfrith SGHWR, together with the principal features of the emergency protection system. Reference is made to commercial SGHWR designs from the point of view of control. The effects of increased size on overall dynamic properties and spatial reactor modes are discussed, together with control system developments to improve load following capabilities. The functions that could usefully be performed by an on-line computer are outlined, although it is emphasized that this is not essential for satisfactory operation. (auth)

13396 FUEL MANAGEMENT IN SGHWRs. O'Dell, F. P. (United Kingdom Atomic Energy Authority, Risley, Eng.); Hopkins, D. R.; Allen, F. R. pp 95-103 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The considerations governing the choice of fuel management schemes in SGHWRs are reviewed. Since the pressure tube construction permits ready access to individual channels, a wide range of schemes is possible and these can be adjusted to suit the requirements of particular installations. As examples, the fuel management schemes evolved for the 100 MW(e) Winfrith reactor, a 350 MW(e) low enrichment design, and a natural uranium version are described. (auth)

13397 PRESSURE TUBE MATERIALS FOR SGHWRs. Nichols, R. W.; Watkins, B. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 115-25 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The properties achieved in the Zircaloy-2 pressure tubes manufactured for the SGHWR are described. It was found that corrosion in-pile is higher than out of the reactor, leading to increased hydrogen absorption in the metal. However, extensive tests, including tests on full size tube, demonstrated that this hydrogen absorption, even in the presence of irradiation embrittlement, will not limit the life of the pressure tubes. Neutron irradiation was also found to increase the creep rate of a Zr alloy under stress and temperature. The present evidence, however, indicates that this will not cause a problem with cold-worked Zircaloy-2 tubes in present designs. Some results on heat-treated Zr-2½% Nb alloy tubes are also described. (auth)

13398 SOME MATERIAL COMPATIBILITY ASPECTS OF SGHWRs. Tyzack, C.; Berry, R.; Campbell, C. S. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 127-34 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The major areas where compatibility aspects are of importance in a SGHW reactor system are reviewed. These include the closely related aspects of selection of materials for primary and secondary circuits and choice of water chemistry regime. Some discussion of work which was carried out in support of the mild steel primary circuit concept is included. The in-pile and out-of-pile aqueous corrosion and H_2 pick-up of Zr alloys used as reactor pressure tube materials is discussed, particularly in relation to differing behavior under oxidizing (neutral) and comparatively reducing environments (NH_3). The materials selection and chemical aspects of the moderator circuit are outlined. (auth)

13399 CHEMICAL CONTROL IN SGHWR CIRCUITS. Dickson, G. K.; Burton, W. R.; Riley, J. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 135-41 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

Chemical control of the moderator involves the removal of corrosion products and nitric acid, and also of B and Li present as a result of the use of D_3BO_3 for reactivity control. A description is given of the resin ion exchange process developed for the Winfrith SGHWR, and of the regeneration procedures. A development of the process for regenerant preparation by means of electrodialysis is outlined. Control of the primary circuit and condensate water conditions is discussed. The Winfrith SGHWR design was based on a stainless steel primary circuit, with a "throwaway" powdered resin unit in the condensate line with blowdown from the primary circuit. Further developments discussed include the use of carbon steels and direct contact feedheaters. (UK)

13400 SAFETY OF THE SGHWR PROTOTYPE. Poulter, D. R.; Johnson, F. G.; Cowking, C. B.; Windle, G. V. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 143-51 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The approach to reactor safety in the UK is reviewed. The vented containment system of the prototype SGHWR is described, along with development of the concept for future reactors using enriched fuel. An outline is given of the work carried out on the release, fate, and clean-up of fission products, the propagation of failures, fuel can performance at high temperature, and containment design. Reference is made to emergency cooling and the provisions for inspection and testing. The method of safety assessment and supporting analytical work are discussed, and the results of fission product release assessments for the prototype reactor are reported. (auth)

13401 COMMISSIONING AND OPERATING EXPERIENCE WITH THE WINFRITH SGHWR. Smith, D.; English, D.; McCrickard, J. (Atomic Energy Research Establishment, Winfrith, Eng.). pp 153-73 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The encouraging results of the first four months operation are reported. The commissioning program is summarized, and the more significant events, from the commencement of fuel and heavy water loading, are described. Results are reported of the main core performance measurements made during commissioning and initial power operation, and their agreement with prediction is shown. (UK)

Power Reactor Development

Refer also to abstracts 13559 and 13564.

13402 (AI-AEC-12721, pp 5-27) REACTOR DEVELOPMENT. Alter, H.; Dunford, C. L. (Atomics International, Canoga Park, Calif.).

Developments in the interactive computer graphics program SCORE are described and include: data storage and retrieval; partitioned memory operation; data correction procedures; spline fitting methods; multilevel analysis of resonance cross sections; and the overlay of ENDF/B evaluated data with the experimental information from the SCISRS file. 18 references are included. (D.C.C.)

13403 (AI-AEC-12721, pp 43-5) REACTOR DEVELOPMENT. Fillmore, F. L. (Atomics International, Canoga Park, Calif.).

The required code development to permit a complete region-dependent weighting spectrum calculation in a single computer run, the linking of CAESAR, AILMOE, and GRISM, is described. (D.C.C.)

13404 (AI-AEC-12721, pp 61-7) REACTOR DEVELOPMENT. Levitt, L. B. (Atomics International, Canoga Park, Calif.).

The development of adjoint Monte Carlo sampling schemes required to implement the third generation Monte Carlo codes is described in detail. The schemes eliminate the need to do adjoint Monte Carlo with multigroup data. They permit identical cross section libraries to be used for direct and adjoint Monte Carlo calculations. (D.C.C.)

13405 (AI-AEC-12721, pp 69-81) NUCLEAR SAFETY. Vaughan, E. U. (Atomics International, Canoga Park, Calif.).

Improvements in present state kinetics codes for use in fast reactor safety calculations are described. The spectrum synthesis method in the one-dimensional static case is explored and tested by comparison with multigroup diffusion theory. Calculations are made with the XMAS-RAUM-PLEASER system on the two-region fast critical assembly ZPR-III-48. (D.C.C.)

13406 (AI-AEC-12721, pp 131-47) FAST REACTOR DEVELOPMENT. Logan, D.; Landoni, J.; Baroczy, C. (Atomics International, Canoga Park, Calif.).

Results from 276 transient boiling tests on superheating of liquid Na are presented. The successful development of a constant heat flux 30 in. long by 0.25 in. OD stainless steel sheath heater and an axially shaped heat flux 36 in. long by 0.25 in. OD stainless steel sheath heater is described. A single channel two-phase transient code, TRANSFUGUE IIa, for use with Na is described. The conversions for a steady state two-phase multichannel steam code, SODIFAZE, and a transient two-phase multichannel steam code, TRANSODIFAZE, are included. (D.C.C.)

13407 (AI-AEC-12721, pp 225-42) FBR FUEL DEVELOPMENT, FUEL CLADDING AND STRUCTURAL MATERIALS FAILURE. (Atomics International, Canoga Park, Calif.).

The effects of He at 540 to 815°C on the tensile properties of Type 316 stainless steel, Type 405 stainless steel, and Incoloy 800 are described. The effects of He on the stress rupture of Type 304 stainless steel are presented. Computer calculations of energy characteristics of vacancy clusters in γ-ions are presented. A description of a high sensitivity gas mass spectrometer system for He analysis is presented. (D.C.C.)

13408 (AI-AEC-12721, pp 363-81) LMFBR COMPONENT DEVELOPMENT. Randall, R. L. (Atomics International, Canoga Park, Calif.).

The feasibility of liquid metal flow rate measurements by use of noise analysis techniques is presented. An instrument for calibrating conventional flow measurement systems is described. (D.C.C.)

13409 (ANL-7518) REACTOR DEVELOPMENT PROGRAM, Progress Report, November 1968. (Argonne National Lab., Ill.).

Dec. 27, 1968. Contract W-31-109-eng-38. 131p. Dep. CFSTI.

Highlights of project activities are summarized for the month of November 1968. Fuel development programs for the LMFBR are described. Operations for the ZPR-3 Assembly 54 and Assembly 55 and ZPPR during November are described. Research and development programs in the EBR-2 are described. Nuclear safety studies, including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

13410 (BAW-1280-49(Vol.1)) FAST TEST REACTOR CONCEPTUAL DESIGN. Final Topical Report. Task A, Phase II and III. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 29, 1967. Contract AT(11-1)-1280. 182p. Dep. CFSTI.

Design studies of selected features of two reactor vessel concepts are presented. The two concepts are identified as the annulus Na inlet concept and the downcomer Na inlet concept. Depth of studies were limited principally to steady state, full power temperature and pressure conditions. Computations were restricted in the most part to ASME Nuclear Code formulas. Pressure vessel boundary requirements in terms of function, structure, material, hydro-test demands, support, guidance and closure head cooling features were studied. A closure head system cooled to 700°F, for a 1200°F sodium outlet temperature, appears feasible. Material design considerations have been presented which account for environment and temperature. However, the underlying premise is that material considerations will be documented by the early operation of FFTF. Further study is needed to explore in depth more of the design basis. (auth)

13411 (BAW-1280-49(Vol.2)) FAST TEST REACTOR CONCEPTUAL DESIGN. Final Topical Report. Task A, Phase II and III. Volume 2. Appendixes. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 29, 1967. Contract AT-(11-1)-1280. 299p. Dep. CFSTI.

Conceptual design specifications and drawings are presented for FTR vessel support, shell flange, upper shell, inlet nozzle, outlet nozzle, core support flange, core support shell, lower shell, downcomer, vessel flange, lower core support shell, and plenum. (D.C.C.)

13412 (GA-8530) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending February 29, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 29, 1968. Contract AT(04-3)-167. 120p. Dep. CFSTI.

CARBON—coatings of for uranium carbide (UC$_2$) particle-type fuel elements, effects of pressure and temperature on performance of
CESIUM—sorption by graphite of, effects of pressure and temperature on
FISSION PRODUCTS—concentration in graphite for 1000 MW(e) HTGR-type reactor, effects of pressure and temperature on
GRAPHITE—sorption of cesium and strontium by, effects of pressure and temperature on
—radiation effects on creep properties of, analysis at 850° to 1200°C of fast neutron
NEUTRON CROSS SECTIONS—calculation of uranium-233, revised
NEUTRONS, FAST—effects on creep properties of graphite, analysis at 850° to 1200°C of
RADIOCHEMICAL PROCESSING PLANTS—operation for HTGR-type reactor fuels of, economics for
REACTIVITY—oscillations in 1000 MW(e) HTGR-type reactor, effects of xenon behavior on
—worth of coke-dispersed HTGR-type reactor fuel elements, calculation of
REACTOR FUEL ELEMENTS—recycle economics for HTGR-type reactor, analysis of optimum reprocessing
—reactivity worth of coke-dispersed HTGR-type reactor, calculation of
—performance of 1000 MW(e) HTGR-type reactor laminar carbon- and silicon carbide (SiC)-coated uranium carbide (UC$_2$) particle-type, effects of pressure and temperature on
REACTORS, GAS-COOLED—core orifices for 1000 MW(e) HTGR-type, design parameters for elimination of
—physics parameters for 1000 MW(e) HTGR-type, digital computer programs for
—reactivity oscillation in 1000 MW(e) HTGR-type, behavior of xenon in
—core parameters for 1000 MW(e) HTGR-type
—fuel elements for 1000 MW(e) HTGR-type, effects of pressure and temperature on performance of laminar carbon- and silicon carbide (SiC)-coated particle-type uranium carbide (UC$_2$)
SILICON CARBIDES—coatings of for uranium carbide (UC$_2$) particle-type fuel elements, effects of pressure and temperature on performance of
STRONTIUM—sorption by graphite of, effects of pressure and temperature on
URANIUM CARBIDES—fuel for 1000 MW(e) HTGR-type reactor of particle-type, effects of pressure and temperature on laminar carbon- and silicon carbide (SiC)-coated
URANIUM ISOTOPES U-233—neutron cross section calculations for, revised
XENON—behavior in 1000 MW(e) HTGR-type reactor

13413 (GA-8576) GAKIT: A ONE DIMENSIONAL MULTIGROUP KINETICS CODE WITH TEMPERATURE FEEDBACK. Froehlich, Reimar; Johnson, Stephen R.; Merrill, Meldon H. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 10, 1968. Contract AT(04-3)-167. 276p. Dep. CFSTI.

The computer code GAKIT is a one dimensional multigroup diffusion theory kinetics code allowing temperature feedback based on a two dimensional heat transfer calculation. GAKIT is a combination of the one dimensional kinetics code GAKIN and of a heat transfer routine which is a modified version of the RZTMP 2 subroutine used in BLOOST before the development of RAT. (D.C.C.)

13414 (JPRS-47282) ATOMIC POWER ENGINEERING AND ITS ROLE IN TECHNICAL PROGRESS. Aleksandrov, A. Translated from Nauka Zhizn, No. 11, 32b-9b(Nov. 1968). 23p. CFSTI.

A general description of the development of atomic energy to the present-day technology is presented. Applications of atomic energy are described. (D.C.C.)

13415 (ORNL-TM-2395) ORCENT: A DIGITAL COMPUTER PROGRAM FOR SATURATED AND LOW SUPERHEAT STEAM TURBINE CYCLE ANALYSIS. Bowers, H. I. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 90p. Dep. CFSTI.

The program will perform full-load, design point calculations for steam turbine cycles supplied with throttle steam characteristic of contemporary water reactor power plants and will handle both condensing and back-pressure turbine exhaust arrangements. Turbine performance calculations are based on the General Electric Company method for large steam turbine-generators operating with saturated and low superheat throttle steam. Output includes all information normally shown on a turbine cycle heat balance diagram. The program is written in Fortran IV for the IBM 360/75 computer at Oak Ridge National Laboratory. (auth)

13416 (TID-8200(19th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF DECEMBER 31, 1968. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 34p. Dep. CFSTI.

A complete revised listing is given for all reactors in the U. S. and all reactors manufactured by U. S. companies which have been exported. The name of the reactor is listed with location, principal nuclear contractor, type of reactor, power, and startup date. Reactors are organized by: civilian reactors, production reactors, military reactors, and reactors for export. (M.L.S.)

13417 (TID-24681) NUCLEAR POWER AND WATER DESALTING PLANTS FOR SOUTHWEST UNITED STATES AND NORTHWEST MEXICO. Executive Summary. (Joint United States-Mexico-International Atomic Energy Agency Study Team). Sept. 1968. 24p. Dep. CFSTI.

An administrative summary of the report on the feasibility of a joint U. S.-Mexican nuclear power-desalting project is given. Conclusions and recommendations are presented. Region of study, plant location, requirements for water, requirements for power, nuclear and water plant technology, and systems and economics are summarized. (M.L.S.)

13418 (TID-24767) NUCLEAR POWER AND WATER DESALTING PLANTS FOR SOUTHWEST UNITED STATES AND NORTHWEST MEXICO. (Joint United States-Mexico-International Atomic Energy Agency Study Team). Sept. 1968. 392p. Dep. CFSTI.

Results of the international feasibility study on the use of large dual-purpose desalting plants for providing electric power and fresh water in the arid southwestern U. S.-northwestern Mexico area are given. Water requirements for the U. S. and Mexico are outlined. The power systems for both countries are described. Use of light water power reactors is discussed; liquid metal cooled and molten salt reactors are considered for dual-purpose plants. Design parameters for advanced evaporators are tabulated. The various sites for the reactor-desalination complex are described. Economics and total production of the complex are detailed. (M.L.S.)

13419 (WCAP-3269-75) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Summary Report of Descriptions of Topical Reports Prepared Under AEC Contract AT(30-1)-3269. Weingart, E. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Dec. 1967. Contract AT(30-1)-3269. 52p. Dep. CFSTI.

A summary of reports produced under the Large Closed-Cycle Water Reactor Research and Development Program is presented. (D.C.C.)

13420 DESIGN OF ADVANCED THERMAL REACTOR. Shima, Shiro (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo, 14: No. 10, 33-40(Oct. 1968). (In Japanese).

The reactor type to be developed in Japan is the heavy water-moderated, boiling light water-cooled reactor, and one of its main aims is to establish and prove the self-sustaining cycle of Pu. The objectives of the primary design of the prototype reactor in the Power Reactor and Nuclear Fuel Development Corp. are to put the design concepts of five nuclear industry groups together in one project; to lay emphasis on the design of core structure, primary cooling system, regulator for reaction rate, fuel assembly, and fuel replacing equipment of the prototype reactor; to design as quantitatively as possible the dynamic characteristics and the measuring and controlling systems; and to determine the fundamental policy for safety. The output of the prototype reactor is 165 MW(e). It has two experimental loops with heat-removing capacity of 150% as much as the hot channel, in the core. The primary cooling system is divided in four independent groups. The optimization calculation of the reactor proper; the fuel plan and the proving plan of self-sustaining of Pu; the thermo-hydrodynamical design; the regulation of reaction rate; the design of core structure; nuclear fuel; the fuel replacing equipment; the analysis of dynamic characteristics; the primary cooling system; the heavy water system and the helium system; the measuring and controlling equipments; the emergency cooling system; and the safety analysis are described. (NSA of Japan)

13421 SODIUM TECHNOLOGY AND FAST BREEDER DEVELOPMENT. Furukawa, Kazuo (Japan Atomic Energy Research Inst., Tokyo). Shin Kinzoku, No. 48: 1-5(July 1968). (In Japanese).

Na technology and fast breeder development are described in the following: features of the liquid Na cooling; other coolants for breeders; the present state of Na technology developments; and problems in the development of Na technology. (NSA of Japan)

13422 15th SECTIONAL MEETING OF THE WORLD POWER CONFERENCE, TRANSACTIONS, TOKYO, 16–20 OCTOBER 1966. VOLUME III. Tokyo, Japanese National Committee, World Power Conference, 1966. 625p. (In English and French). (CONF-661066(Vol.3)).

Included are 34 papers on technical and economic aspects of hydro, thermal, and nuclear power generation. Separate abstracts were prepared for 13 papers on power reactor development. (H.D.R.)

For abstracts of individual papers see: 12606, 13423–13431, 13518, 13528, and 13529.

13423 CANDU REACTORS TO 1980 AND IN THE LONG TERM. Gray, J. L.; Lewis, W. B.; Haywood, L. R. pp 1487-97 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

The technical accomplishments and the general power reactor position in Canada are reviewed, and predictions are made for the period to 1980. The role of CANDU reactors in the longer term when their near-breeder capability and flexibility of fueling promises to meet any problem of fuel resources and to retain a competitive position is examined. Four fuel cycles appropriate to different costs of natural uranium and fuel reprocessing are discussed. (H.D.R.)

13424 EVALUATION OF THE FUTURE PARTICIPATION OF NUCLEAR POWER IN ARGENTINA. Csik, Bela Jose. pp 1498-1506 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

The need for nuclear power as a long range solution to the energy requirements of Argentina is established on the basis of the rate of development of the country and its available fossil fuel and hydro-power resources. A short description of the principal aspects of a feasibility study, completed in 1965, for a power reactor to be installed in the Greater Buenos Aires–Littoral area is presented. The main conclusions of the study are summarized. (auth)

13425 FUTURE ON NUCLEAR STEAM POWER GENERATION. Richards, R. B.; Schabtach, Carl. pp 1545-58 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

The present state of the art in nuclear power plants using boiling water reactors is discussed. Major reduction in both capital cost and fuel cycle cost have been achieved in the six years since Dresden I first produced commercial power. Improvements in the reactor and turbine, as well as a strong tendency by utilities to purchase units of large rating, have been responsible. These are outlined in detail, and the direction of future developments is indicated. (auth)

13426 NUCLEAR PLANTS WITH INCORPORATED PRIMARY CIRCUITS: TECHNICAL, ECONOMIC, AND SAFETY ASPECTS. Cabanius, J.; Roux, J. B. (Electricite de France, Paris). pp 1559-75 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966. (In French).

See CONF-661066–(Vol.3).

The French nuclear program is based on reactors of the natural uranium–graphite–gas type. Each of the units successively built as part of this program denotes an advance over the previous ones In the case of E.D.F.4, the integrated arrangement was adopted for the reactor. In this arrangement, the core, exchangers and cooling pipes are all housed in a single prestressed-concrete pressure vessel. This arrangement can also be applied to other types of reactors. A close comparison between E.D.F. 3 and E.D.F. 4 reveals advantages from both technical and economic standpoints. Finally, the inherent safety of this arrangement makes it possible to contemplate further developments of the natural uranium–graphite–CO_2 system, and should simplify the choice of plant sites. (auth)

13427 CONSIDERATIONS ON LARGE NUCLEAR PLANT EVOLUTION WITH SPECIAL REFERENCE TO THE EXPERIENCE WITH THE ITALIAN NUCLEAR STATIONS. Angelini, Arnaldo M. (ENEL, Rome). pp 1576-90 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

After a few considerations on the present state of nuclear technology and on the technical and economic factors which play a determining role in a power utility's choice of a reactor type, a brief review is made of the main characteristics of the Italian nuclear stations at Latina (210 MW(e); Magnox type), Garigliano (160 MW(e); BWR) and Trino Vercellese (270 MW(e); PWR). The experience acquired from the design, construction and operation of the three stations is discussed in more detail, and information is provided on power generation, plant availability and flexibility, The main difficulties experienced during operation are described and the data relating to the economics of these plants are discussed. In view of the fact that the present state of nuclear technology and the characteristics of the Italian grid are such as to justify the belief that the next Italian nuclear station will be much larger than the present ones (i.e., 600 MW(e) or more), a survey is made of the technical and economic progress in the nuclear field since the decision to build the first three Italian stations. In the light of the experience acquired in Italy and elsewhere, a discussion is made on the problems confronting a public utility today in the choice of a reactor type among all the more or less proven types considered capable of producing energy competively on a commercial scale. The position of the power utilities with respect to the delicate matter of the advisability of encouraging the development of an increasing number of new reactor types is considered. (auth)

13428 HOW WE ARE GOING TO INTRODUCE COMMERCIAL ATOMIC POWER INTO JAPAN. Sagane, Ryokichi (Japan Atomic Power Co., Tokyo). pp 1591-1602 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

The status of commercial atomic power applications in Japan is presented with a rough prediction of the future. A number of arguments issued for the future programs are also outlined. (auth)

13429 ADVANCED TYPES OF NUCLEAR POWER REACTORS AND THEIR INTEGRATION INTO ELECTRICITY GENERATING SYSTEMS. Stewart, J. C. C.; Moore, R. V. pp 1625-38 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

In the United Kingdom, thermal reactors will contribute 5,000 MW(e) of generating capacity by 1970 and a further 8,000 MW(e) by 1975. Moreover they will have an important place in the U.K. system until the end of this century. The implications of a large nuclear power program are discussed. To get a long term supply of energy an initial source of highly enriched material is needed for a series of fast reactors, which can breed the fuel they require subsequently. The best source of this high enrichment is plutonium produced in a series of thermal reactor power stations. This leads to an integrated approach to nuclear power programs. The characteristics of reactors which are being developed in the U.K. are described, with particular reference to the balance of fissile material consumption and production. The main emphasis of the U.K. reactor development program in the years immediately ahead will be the 250 MW(e) sodium-cooled Prototype Fast Breeder Reactor to be constructed at Dounreay, Caithness, Scotland. At Winfrith Heath in Dorset, the prototype Steam Generating Heavy Water Reactor of 100 MW(e) is nearing completion and the special features of this type of reactor, which is economic over a wide range of outputs, are mentioned. Consideration has also been given to the place which the High Temperature Gas-cooled Reactors might have in the U.K. generating system. (auth)

13430 SELECTION OF POWER REACTORS FOR ELECTRICITY GENERATION IN ENGLAND AND WALES. Berridge, D. R.; Gott, H. H.; Jackson, G. B. (Central Electricity Generating Board, London). pp 1639-53 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16-20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066-(Vol.3).

The selection of power reactors for England and Wales are discussed against the background of Magnox operating experience and taking account of the expected development of the C.E.G.B. system. The Dungeness "B" tenders indicated that a substantial nuclear power program could now be justified on economic grounds. It is forecast that before 1980 the majority of new C.E.G.B. plants coming into service will be nuclear, and by 1985 the nuclear capacity is expected to be such that some load factor restriction will be imposed. Important requirements for future reactor types are identified, including freedom from siting restrictions on grounds of safety, minimum cooling water requirements, high availability, flexibility in operation and good potential for development to larger unit sizes. The C.E.G.B.'s encouraging operational experience with the early Magnox stations is summarized, with special reference to safety, availability, maintenance and fuel handling. Simplification in design and operation of future nuclear stations is the main objective indicated by experience, and in this context the use of oxide fuel canned in stainless steel is cited as one of the attractive features of the AGR. A preliminary comparison in 1963 of the leading reactor types led to the decision to invite tenders for AGR and proven water reactors for the Dungeness "B" station. Recent developments in the chosen AGR design are described. The main desirable features for future C.E.G.B. nuclear stations are reviewed, and a brief discussion of other thermal reactors which could find application in the U.K. and of the U.K.A.E.A.'s fast breeder reactor program is presented. (auth)

13431 POWER GENERATION IN SOUTH AFRICA WITH SPECIAL REFERENCE TO THE INTRODUCTION OF NUCLEAR POWER. Straszacker, R. L.; Roux, A. J. A.; Harding, G. R. D.; Grant, W. L. pp 1654-73 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16-20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066-(Vol.3).

The present power generating organization in South Africa is described together with the electricity generating undertakings into which the country is divided. A survey is given of the power plants and power distribution. Future power requirements are discussed together with the area where the construction of large coal-burning power stations is likely to take place. Limitations on the increasing use of coal-burning power stations are mentioned with special reference to the cooling water supply problem. The introduction of nuclear power along the coastal regions presents a possible solution to the cooling water problem and is briefly discussed. A description is given of the reactor concept which is under development by the South African Atomic Energy Board, and the future program with regard to nuclear power development is briefly set out. (auth)

13432 SYSTEM PLANNING STUDIES IN DENMARK WITH A SPECIAL VIEW TO THE INTRODUCTION OF LARGE NUCLEAR UNITS. Knudsen, J. Ehlert. pp 1793-1809 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16-20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066(Vol.4).

The two separate Danish power systems will have about 2000 MW installed capacity each in 1970. Thanks to the powerful ties to Sweden and Germany, units can be installed in sizes matching much larger systems. The rapidly increasing load in connection with the development of economically competitive nuclear power and the prospects of low investment cost thermal plants and of gas turbine peaking units justified a very comprehensive study of future generation patterns in Denmark. The study demonstrated that units as large as 500 MW can be introduced even in systems of a fairly small size provided that these are pooled with larger systems through strong ties. It is concluded that even if the low fossil fuel prices remain stable in the future, nuclear power in large units will be attractive in the relatively small Danish power systems — even more when a fully coordinated expansion, assuming an internal interconnection, is contemplated. (auth)

13433 FUTURE DEVELOPMENT TREND OF HYDROELECTRIC AND THERMAL POWER STATIONS AND TRANSMISSION SYSTENS FOR TOKYO. Hori, Ichiro (Tokyo Electric Power Co., Inc.). pp 1969-86 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16-20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066(Vol.4).

Tokyo Electric Power Co., Inc. supplies power, up to a maximum of 8000 MW, to the entire Kanto District, centered around Tokyo. Described are the principal features of the finalized plan under which the development program for future power supply is being carried out to meet increasing demands in the Tokyo area. Present maximum annual consumption in Tokyo is 2800 MW, with an estimated future annual demand increase of approximately 300 MW. From the standpoint of generating capacity, it will be necessary for TEPCO to develop generating capacity of about 1000 MW per year, in order to meet future demand increases in the Kanto District. To accomplish this, TEPCO decided to develop thermal power stations based on supercritical pressure units (600 MW) to take care of the major portion of this demand and to establish pumped storage type power stations (900 MW) for peak demands. Thus, rational power stations are being developed to meet potential demand increases. At the same time, TEPCO is taking aggressive action in developing nuclear power stations to provide for future power expansion. In the field of transmission systems, TEPCO has decided to use 500 KV on the outer loop of the existing 275 KV system. The first 500 KV transmission line has been completed. With respect to the Tokyo internal systems, TEPCO is developing 154 KV underground systems. Plans also call for an additional 275 KV underground system. (auth)

13434 THE INTRODUCTION OF NUCLEAR POWER IN SOUTH AFRICA. Roux, A. J. A. S. Afr. Mining Eng. J., 79: 1577-8 (June 21, 1968).

At the present rate of demand increase, and with present mining methods, South Africa's coal may be exhausted in 50 to 60 years. The country will, therefore, need nuclear power soon. The Atomic Energy Board has now submitted its full report on the introduction of nuclear power to the Minister of Mines. Economic justification of nuclear power is analyzed. Present indications are that a natural U reactor, moderated and cooled by heavy water, would be the most suitable type for South African conditions. The capital cost of these reactors is at present lower than for other types of natural U reactors; it also appears to be more economical as far as U consumption and Pu production is concerned. The reactor type finally chosen, however, will be one that has been designed, developed and proven overseas. (BBB)

13435 ECONOMIC HEAVY WATER POWER REACTORS. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 175-80 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The advantages of the Canadian reactor design are demonstrated by reference to the standard low cost natural uranium fuel, with established irradiation performance, and to the operation and maintenance aspects. The use of boiling light water instead of pressurized heavy water, and the possibilities in the development of the organic cooled concept, are considered. Examples of encouraging results are reported in the fields of pressure tube materials and heavy water leakage control. (UK)

13436 GERMAN CONTRIBUTION TO THE DEVELOPMENT OF D_2O MODERATED REACTORS. Keller, K. F. W.; Stueger, R. A. pp 187-95 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The work of Siemens and its associates in the development of reactors fueled by natural uranium and moderated by heavy water is described. Both pressure tube and pressure vessel designs were produced, the tube reactor being cooled by CO_2. These reactors and also the 320 MW(e) power plant of the pressure vessel type, recently ordered by the Argentine CNEA are described. The further development of the D_2O vessel system to larger units involving concrete vessels and integral steam generators is outlined, and the possibility of employing a thorium fuel cycle is discussed. (auth)

13437 THE CIRENE REACTOR CONCEPT. Villani, S. (Centro Informazioni Studi Esperienze, Milan). pp 197-206 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

The main characteristics of a typical 1600 MW(t) CIRENE reactor design are discussed, and some data reviewed in comparison with the SGHWR and the CANDU-BLW. A basic difference between CIRENE and the SGHWR is concerned with reactor physics. The former has to accept operation with a considerable coolant void coefficient; this fact has to be duly taken into account in the design of the control and safety systems, which are described in some detail. A summary is also given of the refueling procedures. The development of the CIRENE reactor is stated to be justified on economic grounds in the content of the long-term forecasts for the growth of power demand in Italy. (auth)

13438 THE SWEDISH PROGRAMME ON VESSEL HWRs. Margen, P. H. (Aktiebolaget Atomenergi, Stockholm). pp 207-24 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

Swedish HWRs use D_2O as moderator and coolant and pressure vessels. The Agesta PHWR has operated since 1963/64 with very low D_2O leakage and high availability. Commissioning of the Marviken 200 MW(e) BHWR is due for early 1969. Features of these units and of designs for commercial BHWRs are discussed. Current designs for large BHWRs use concrete pressure vessels, and a project for building a model vessel in Sweden has started. Discussions of economic and technical parameters indicate that expected trends for the cost of U, plutonium, fuel fabrication, reprocessing, and the size of units all favor natural U HWRs in general, and the highly neutron economic BHWRs in particular. Long term resource considerations, and the important part which HWRs could play in this respect, are discussed with reference to very recent international studies. (auth)

Kinetics and Dynamics

13439 (AE-341) NONLINEAR DYNAMIC MODEL OF POWER PLANTS WITH SINGLE-PHASE COOLANT REACTIONS. Vollmer, Heinz (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1968. 33p. Dep

It is suggested that a power reactor model development may be made more systematic, general and flexible by: applying the "box of bricks" system, where the main components of a nuclear power plant are treated separately and combined afterwards according to a given flow scheme; a dynamic determination of the components which is as general as possible without taking into account those details which have a minor influence on the overall dynamics; providing approximations of the more rigorous solution sufficient to meet the user's requirements on accuracy; and proper use of computers. A dynamic model for single-phase coolant reactor plants was established along these lines. By separation of the nonlinear and linear parts of the system, application of Laplace transformation and proper approximations, and the use of a hybrid computer it seems possible to determine the nonlinear dynamic behavior of such a plant for perturbations which are not so large that phase changes of physical parameters occur, e.g. fuel does not melt. The model is applied to a steam-cooled fast reactor power plant. (auth) (Swed)

13440 (AI-AEC-12721, pp 47-59) GENERAL REACTOR TECHNOLOGY. Paschall, R. K. (Atomics International, Canoga Park, Calif.).

In the fast reactor physics program the following topics are discussed: proton recoil spectra in Na; γ shielding studies in ECEL; and electronic circuit development. (D.C.C.)

13441 (APED-5640) XENON CONSIDERATIONS IN DESIGN OF LARGE BOILING WATER REACTORS. Crowther, R. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 1968. 43p.

Design characteristics for large boiling water power reactors (BWR) are tabulated. The relative power in a BWR is shown as functions of relative water density and neutron multiplication; effects of BWR variables on power coefficients are evaluated. Load following effects on spatial xenon stability are analyzed; spatial damping and power distributions are determined. Load following characteristics for Dresden Power Reactor Unit 1 are shown graphically; reactor stability, load stability and in-core variations resulting from a step change in power level are shown also. Use of coolant flow control as a load follow-control mechanism is detailed; parametric studies of flow control effects on xenon oscillations are shown graphically. 15 references. (M.L.S.)

13442 (WCAP-3680-8) CONTROL OF XENON INSTABILITIES IN LARGE PWR'S. Quarterly Progress Report for the Period Ending September 30, 1968. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1968. Contract AT(30-1)-3680. 24p. (EURAEC-2067). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A procedure for controlling Xe-induced spatial oscillations in large pressurized-water reactors is developed and demonstrated. (D.C.C.)

13443 FISSION PRODUCT HEATING IN FAST REACTOR PLUTONIUM FUEL. Battat, M. E.; Dudziak, D. J.; Johnston, K. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Nucl. Energy, 22: 703-4(Nov. 1968).

A revised set of "best equations" for $H\beta + \gamma$, $H\beta$, and $H\gamma$ of the type derived by Way and Wigner is presented. A discrepancy had been found in the fitting procedure used to obtain the equations published previously [Johnston, NSA 19: 42114]. (UK)

Control Systems

13444 (APED-5706) IN-CORE NEUTRON MONITORING SYSTEM FOR GENERAL ELECTRIC BOILING WATER REACTORS. Morgan, W. R. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1968. 72p.

A description of the neutron monitoring system used in General Electric Boiling Water Reactors is presented. The sensors used for the system are all located within the physical boundaries of the fueled region of the reactor core. Three types of miniature fission chambers are mounted vertically in the spaces between fuel bundles. Signal conditioning equipment and trip and alarm functions are described. Redundancy is discussed as it is used to assure safe operation in case of failed and/or bypassed components. (auth)

13445 (CEA-Note-862) UTILIZATION OF THE COMPUTER FOR CONTROL AND OPERATION OF NUCLEAR REACTORS. Weill, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 30p. (In French). (CONF-670657-1). Dep.

From 2nd International Conference on Electronics and Automation, Hercegnovi, Yugoslavia.

Use of the computer for on-line control and operation of French reactors is discussed. Data acquisitions and treatment is discussed. Descriptions and evaluations are given for the on-line computers at Cabri, Rapsodie, EL-4, and Osiris. (M.L.S.)

13446 (GAMD-8734) HTGR POWER PLANT CONTROL USING MANUAL, AUTOMATIC, AND DIGITAL COMPUTER CONTROL. Krell, J.; Long, H. A. (Gulf General Atomic, Inc., San Diego, Calif.). June 24, 1968. Contract AT(04-3)-167. 35p. Dep. CFSTI.

The history, state-of-the-art, and forecasts for digital computer control systems for reactors are described. A summary of present digital computer control systems is presented. The development of a digital computer control system for a high-temperature gas-cooled reactor is described. 62 references. (D.C.C.)

13447 (NP-17751) CONTROL OF FRENCH REACTORS: METHODS AND ACTUAL INSTRUMENTATION; DETECTION OF CLADDING FAILURE. Weill, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1967. 130p. (In French). Dep.

The control characteristics peculiar to Pegase are outlined; the startup system for Osiris is described. Types of instrumentation used in the French reactors are discussed; types and uses of detectors are listed. French reactor control electronics are discussed; characteristics and performance of instrument modules are detailed. Digital and Campbelling techniques are discussed; associated electronic equipment is described. Methods used to detect fuel element rupture in the Na and gas cooled French reactors are discussed. 30 references. (M.L.S.)

13448 DIRECT DIGITAL REGULATION CONTROL SURVEILLANCE BY COMPUTER OF IRRADIATION PILES. Perret, R.; Joumard, R. Automatisme, 13: 153-9(Apr. 1968). (In French).

Direct computer control has been successfully applied to nuclear reactors for irradiation. (UKAKA Info. Bull.)

Shielding

13449 (AERE-R-5773(Vol.1)) PROCEEDINGS OF THE CONFERENCE ON THE PHYSICS PROBLEMS OF REACTOR SHIELDING HELD AT THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, SEPTEMBER 26–29, 1967. (British Nuclear Energy Society, London (England)). May 1968. 340p. (CONF-670932-(Vol.1)). Dep. CFSTI. UK £ 9-8-0 (Vols. 1–5).

Included are 14 papers on bulk shielding calculations for reactor shield design and evaluation. Various approaches to the solution of the neutron transport equation in one dimension are presented. Separate abstracts were prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 12939–12945 and 13450–13456.

13450 (AERE-R-5773(Vol.1), pp 5-40) SABINE: A ONE-DIMENSIONAL SHIELDING PROGRAMME WHICH EMPLOYS EXPERIMENTAL REMOVAL CROSS SECTIONS. Nicks, R.; Perlini, G.; Ponti, C. (European Atomic Energy Community).

The program SABINE provides an effective and flexible tool for the solution of practical shielding problems in plane, cylindrical and spherical geometry. It is a FORTRAN IV program for IBM 7090 or 360. Neutron fluxes for 26 energy groups are calculated with the removal diffusion model; particular attention is paid to the coupling of the removal flux with the diffusion equations. Energy dependent removal cross sections for water, C, Al, Fe, Pb, and terphenyl were measured at the 5.5 MeV accelerator of Padova University. Gamma fluxes for 7 energy groups are calculated considering the radiation emitted by fission, neutron capture, and inelastic neutron scattering; three forms of region dependent build-up-factors may be used to determine the γ fluxes: build-up-factors for 6 materials were calculated with the BIGGI 3 γ transport program. Other quantities calculated by SABINE may be any neutron response function, γ dose and energy deposition. A set of comparisons between calculations and measurements for water, Fe-water and heavy concrete shields is presented and the results are discussed. (auth)

13451 (AERE-R-5773(Vol.1), pp 41-75) McBEND: A PROTOTYPE CODE UTILISING BOTH REMOVAL-DIFFUSION AND MONTE CARLO METHODS. Bendall, D. E.; McCracken, A. K. (Atomic Energy Establishment, Winfrith (England)).

Work is described on McBEND, a prototype one-dimensional shielding code in which either multigroup removal-diffusion methods or Monte Carlo techniques may be specified by the user. Variance reduction in the Monte Carlo option is achieved by particle splitting applied in energy-space. Splitting is determined by reference to value functions which are first obtained as solutions of adjoint removal-diffusion equations. The use of both scalar and vector value functions is considered and examples are shown of the use of the former for various detector distribution functions of interest to shield designers. The multigroup removal-diffusion equations used to derive value functions for the Monte Carlo may be used directly for parametric shielding studies when the use of Monte Carlo is not justified. The choice of appropriate removal cross sections is discussed, and it is shown that suitable cross sections may be derived with the aid of the adjoint equations from either high-quality measurement or the results of nominally exact calculations of neutron penetration. (auth)

13452 (AERE-R-5773(Vol.1), pp 76-85) THE REMOVAL-DIFFUSION NEUTRON SHIELDING CALCULATIONAL METHOD: COMPARISON OF DIFFERENT INTERPRETATIONS. Retief, J. V. (Atomic Energy Board, Pretoria (South Africa)).

The MAC-RAD neutron shielding programme was modified to resemble the RASH and NRN interpretations of the removal-diffusion model, particularly the definition of the removal cross-section, and the scheme of transfer from removal to diffusion flux. Calculations with the different modifications were intercompared, and as a control, compared to the Moments Method results for concrete. The MAC-RAD results were not very accurate nor reliable; the inconsistency of the transfer scheme used was demonstrated to be significant. The MAC-RASH and MAC-NRN programmes both gave accurate results for any design purposes and did not differ much from each other. For both programs, however, the mechanism of attenuation did not agree with that of the Moments Method, mainly due to an over-estimation of the attenuation of the diffusion component, which is corrected for by over-estimating the removal component. To improve the reliability of the method, it was modified to give a more accurate prediction of the mechanism of attenuation: This was achieved by introducing a P_2-correction to the diffusion coefficient, and by using larger values of the removal cross-section in a MAC-NRN calculation. (auth)

13453 (AERE-R-5773(Vol.1), pp 89-121) USE OF DIFFUSION-THEORY FOR TRANSPORT CALCULATIONS. Ackroyd, R. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group).

A way of calculating transport effects is described for application to reactor and shielding problems. Where transport effects are negligible the methods reduce to classical diffusion theory. An approximate form of transport theory, quasi-transport theory, is proposed, and the reduction of transport theory to a form similar to multi-group diffusion theory is given for anisotropic scattering in plane systems. A number of applications for quasi-transport theory are given. Results were obtained using the CRAM diffusion code. (H.D.R.)

13454 (AERE-R-5773(Vol.1), pp 122-52) COMPARISON OF DIFFUSION THEORY TO TRANSPORT CALCULATION RESULTS. Fiebig, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht (West Germany). Institut fuer Reaktorphysik).

Generally in shield-arrangements the premises for using diffusion theory are not fulfilled. Nevertheless, combined multigroup diffusion and removal codes are used with good success where the group constants are obtained by application of reasonable assumptions. The errors include: (1) The neutron spectrum is different from the real space dependent neutron spectrum. (2) The angular dependence of the neutron flux may not be described by the P-1 approximation. The last point may be corrected to some extent by using a B-1 approximation for the evaluation of the diffusion constant. But all methods of averaging are not able to regard variations of the neutron spectrum as a function of the layer thickness, the neighboring materials, and the influence of the transients at layer boundaries. Using a new neutron-transport code BINE, neutron spectra in plain water-iron-water arrangements were calculated in the energy region from 2.3 MeV to 7 keV. These spectra were used for: (1) Study of space-dependence of (locally derived) multigroup constants. (2) Evaluation of layer-averaged multigroup constants and their variation as a function of layer thickness. (3) Comparison of transport solutions with results of multigroup diffusion calculations using these region-averaged group constants. The results of these calculations are discussed. (auth)

13455 (AERE-R-5773(Vol.1), pp 153-60) APPROXIMATION OF THE TRANSPORT EQUATION WITH FINITE DIFFERENCE EQUATIONS. Verschuur, K. A. (Reactor Centrum Nederland, Petten).

A second order finite difference equation with constant mesh spacing is given, which in an infinite medium with exponential sources, approximates the transport equation quite well, even for relative high values of the logarithmic derivative of the source distribution and for relative high values of the absorption cross section. By using appropriate boundary conditions the method is extended for use in finite media problems. The mesh distance is taken proportional to the mean free path. This physically means that one simulates the fact that the neutron flux at a certain point is composed of neutrons which have traveled on the average a finite distance. The mesh distance is approximately two times the mean free path. A computer program, based on this method, calculates the mesh spacings. So no uncertainty remains about the inaccuracy due to finite mesh spacing. The usefulness of the method is discussed and a comparison with S_n calculations is made. (auth)

13456 (AERE-R-5773(Vol.1), pp 163-71) SOLUTIONS OF THE NEUTRON TRANSPORT EQUATION IN ONE DIMENSION. Bonsall, W. (United Kingdom Atomic Energy Authority, Risley (England). [Reactor Group]).

The spherical harmonics equations of transport theory in plane geometry with isotropic scattering and isotropic source distribution, with distance measured in mean free paths, do not contain any material parameters except in the first equation. Polynomial and trigonometric solutions to the infinite set of equations excluding the first are presented. Inserting any one of these solutions in the first equation gives a source distribution which would give rise to the flux distribution inserted. The usual problem of finding a flux distribution arising from a given source distribution can therefore be inverted, one can synthesise an approximation to a given source distribution from a linear combination of some of the known source distributions and the flux distribution follows immediately. Simple examples of the application of the method are given. Similar methods can also be applied with little more effort to anisotropically scattered particles and to problems with spherical symmetry. (auth)

13457 (AERE-R-5773(Vol.2)) PROCEEDINGS OF THE CONFERENCE ON THE PHYSICS PROBLEMS OF REACTOR SHIELDING HELD AT THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, SEPTEMBER 26-29, 1967. (British Nuclear Energy Society, London (England)). May 1968. 259p. (CONF-670932-(Vol.2)). Dep. CFSTI. UK £ 9-8-0 (Vols. 1-5).

Included are 10 papers on the solution of the gamma transport equation in one dimension and on neutron attenuation studies in reactor shielding facilities. Separate abstracts were prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 12946—12949, 13458—13461, 13496, and 13532.

13458 (AERE-R-5773(Vol.2), pp 370-93) USE OF KERNEL TECHNIQUES FOR CALCULATING THE DISTRIBUTION OF HEATING RATES IN MODERATORS. Ackroyd, R. T.; Sidebotham, E. W.; Jackson, A. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group).

The analysis of the distribution and magnitude of the heating rate in a reactor is examined. Problems in calculations of the total energy generated by fission in a fuel element and in the distribution of the absorption by various components of the total energy which escapes from the fuel are discussed. The point source, exponential attenuation kernel approach is used as the basis of a procedure for predicting the transmission and absorption of neutron and gamma radiation. (15 references) (H.D.R.)

13459 (AERE-R-5773(Vol.2), pp 410-48) APPLICATION OF TRANSMISSION AND REFLECTION OPERATORS TO CALCULATION OF GAMMA-RAY PENETRATION THROUGH MATTER. Maute, A. H. (Technische Hochschule, Stuttgart (West Germany). Institut fuer Kernenergetik).

Using transmission anf reflection operators the radiation penetration through plane layers of matter can completely be described by an abstract formulation of transport theory because the operators interpreted as functions of the layer thickness contain the whole information of radiation transport for all boundary conditions. Thus, transmission and reflection can be stated independently of the special problem. As transmission and reflection operators can be specified explicitly by operator series direct computation of given layers is possible without integration of differential equations. Furthermore, composed layers can be calculated by combination of the operators of the single layer. For this reason the numerical presentation of the layer properties by transmission and reflection matrices for γ radiation in plane geometry is investigated. (auth)

13460 (AERE-R-5773(Vol.2), pp 483-514) SODIUM AS A SHIELD COMPONENT FOR FAST REACTORS. Thiele, A. W. (Atomics International, Canoga Park, Calif.); Bunch, W. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A program was conducted to evaluate the accuracy of calculation methods in Na shields. Calculations using Monte Carlo, S_n, and moments method solutions to the Boltzmann equation were performed. These results were compared with measurements of slab geometry shield mockups. The fast neutron measurements were in good agreement with calculations, but at intermediate and thermal energies the measurements showed less attenuation than predicted by the calculations. (16 references) (auth)

13461 (AERE-R-5773(Vol.2), pp 515-53) NEUTRON ATTENUATION STUDIES IN FAST REACTOR SHIELDING. Avery, A. F.; Curtis, G. C. (Atomic Energy Establishment, Winfrith (England)).

Neutron penetration calculations in support of fast reactor designs raise two special problems. First, the spectrum of neutrons leaking from a fast reactor exhibits a large peak at about 100 keV and neutrons in this region are consequently more important than those above 1 MeV. In this situation the removal-diffusion method, which is usually employed for thermal reactor design in the United Kingdom using the COMPRASH program, reduces to straightforward diffusion theory over large penetrations because the spectrum is dominated by neutrons at energies below the 0.5 MeV lower limit of the removal treatment. The second problem arises from the very long migration lengths of neutrons in non-hydrogeneous materials combined with the small size of the core, which calls for a two-dimensional treatment of the source geometry and lateral leakage from the shield. The IBM 7090 program ATTOW provides the solution of this latter type of problem. In order to assess the accuracy of removal-diffusion theory for fast reactor shields, two series of experiments in typical materials have been undertaken at the reactors ZEBRA and LIDO. Removal-diffusion calculations were carried out for these experimental arrays using the ATTOW program in two dimensions and COMPRASH in one dimension. These showed that the theoretical neutron flux values in graphite were dependent upon the widths of the energy groups, and that by choosing a suitable group scheme it was possible to predict neutron fluxes whose values were close to those measured in all of the experiments. In the calculations of reaction-rates in the Na array it was found that the lateral leakage of neutrons was particularly important, and that a two-dimensional treatment with the ATTOW program was essential. (10 references) (auth)

13462 (AERE-R-5773(Vol.3)) PROCEEDINGS OF THE CONFERENCE ON THE PHYSICS PROBLEMS OF REACTOR SHIELDING HELD AT THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, SEPTEMBER 26-29, 1967. (British Nuclear Energy Society, London (England)). May 1968. 335p. (CONF-670932-(Vol.3)). Dep. CFSTI. UK £ 9-8-0 (Vols. 1-5).

Included are 11 papers on shielding calculations for reactor shield design and evaluation. Various approaches to solution of radiation attenuation in ducts and voids and complicated geometries are presented. Separate abstracts were prepared for each paper. (D.C.C.)

For abstracts of individual papers see: 11685, 13463—13471, and 13552.

13463 (AERE-R-5773(Vol.3), pp 600-26) TECHNIQUES FOR CALCULATING THE PENETRATION OF RADIATION IN DUCTS AND VOIDS. Miller, P. C.; Packwood, A.; Parker, J. (Atomic Energy Establishment, Winfrith (England)).

The performance of a power reactor shield is largely controlled by radiation which streams through the various penetrations associated with coolant circuits, refuelling channels, control mechanisms and services. A variety of methods for treating these problems is discussed in the literature ranging from simple line-of-sight techniques to full-scale Monte Carlo calculations with more or less exact representations of the geometry. For simplicity, most design codes employ the albedo concept to predict the build-up of neutrons due to multiple scattering at the walls. The capabilities of simple line-of-sight analysis, albedo and Monte Carlo techniques for gas-cooled power reactors are investigated by comparing predictions with measurements made in various ducts and slot configurations set up in the LIDO and GLEEP experimental facilities. Consideration is also given to the problem of calculating the neutron flux penetrating the lattice of gas-filled channels which constitutes the charge-face reflector of graphite-moderated power reactors. The accuracy of the simple design techniques which are used for predicting the sources of neutron streaming within the charge-face shields of Magnox and A.G.R. systems is established by comparing predictions with both Monte Carlo calculations, and experiments on the axial reflectors of GLEEP and the zero-energy reactor HERO at Windscale. (13 references) (auth)

13464 (AERE-R-5773(Vol.3), pp 627-56) STUDY OF THE NEUTRON DISTRIBUTION IN BENT AIR DUCTS IN A WATER SHIELD. Paratte, J. M. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)).

A theoretical method for the calculation of the neutron flux built up in empty bent ducts by a plane neutron source is presented. The flux is divided into different components which are calculated separately. The reflected neutrons are taken into account by the differential albedos. Three threshold detectors and one detector for thermal neutrons have been irradiated in bent air ducts immersed in the water of the swimming pool reactor SAPHIR. The measurements have been performed for 90°, 45°, 20°, and 0° bend angles. The results of the activity measurements in the straight ducts are compared with theoretical calculations. (3 references) (auth)

13465 (AERE-R-5773(Vol.3), pp 657-709) NEUTRON PROPAGATION THROUGH STRAIGHT AND BENT CYLINDRICAL DUCTS. Canali, U. (European Atomic Energy Community); Chinaglia, B.; Monti, D. (Societa Ricerche Impianti Nucleari, Saluggia (Italy)); Nicks, R. (European Atomic Energy Community).

Fast, epithermal, and thermal neutron propagation through straight and bent cylindrical ducts has been studied at the Lid Tank Shielding Facility ETNA which is located near the thermal column of the Avogadro-1 reactor. Axial and transversal flux profiles were measured with threshold detectors and resonance detectors. A Monte Carlo program has been written to calculate the neutron spectra by simulating the geometrical conditions. A program has also been written to calculate the flux in the duct from the last-collision source in the surrounding medium. The analysis of results for bent ducts was made for fast neutrons by considering the scattering on the walls at the corner and the corner lip effect. (7 references) (auth)

13466 (AERE-R-5773(Vol.3), pp 710-35) THERMAL NEUTRON BEHAVIOR IN SHIELD DUCTS. Channon, F. R.; Seale, R. L. (Arizona Univ., Tucson. Dept. of Nuclear Engineering).

The behavior of thermal neutrons in a water shield containing ducts was studied experimentally and compared with theoretical models. In addition to measuring the total flux, a source separation technique was used to isolate the various flux components, which are: direct component, uncollided neutrons which enter the duct mouth; scattered component, collided neutrons which enter the duct mouth; and penetration component, collided neutrons which originally enter the shield. Duct diameters from $1\frac{1}{8}''$ to $4''$ were considered. The shield absorption properties were altered by dissolving various amounts of boric acid in the water. (auth)

13467 (AERE-R-5773(Vol.3), pp 738-54) NEUTRON AND GAMMA RAY STREAMING THROUGH OFFSET CYLINDRICAL AIR DUCTS IN WATER. Yamaki, Hideo; Fukushima, Yutaka; Uchida, Shunsuke (Hitachi, Ltd., Tokyo (Japan)).

The relationships between radiation, streaming effects and four geometric parameters and cylindrical ducts obtained by means of systematic parameter survey experiments are described. It also compares the experiments with calculations carried out by the ray analysis method for streaming along offset cylindrical ducts. The four geometric parameters of the duct and their ranges for these experiments were: duct values (from 2.5 cm to 15.0 cm); duct length (from 100 cm to 300 cm); location of the step along the duct (from $\frac{1}{8}$ to $\frac{7}{8}$ on total length); and the step width (from zero to 4 times the radius). The dose rate distributions of the leakage radiation were measured along the radial direction behind the duct. A BF_3 counter measured for neutron fluxes and an ionization chamber for γ-ray dose-rates. Streaming calculations were carried out by obtaining the fluxes of unscattered radiation by the ray-analysis method. Furthermore, the effects of dose build up were considered for the γ-radiation transmitted through shield. Results are presented. (7 references) (auth)

13468 (AERE-R-5773(Vol.3), pp 755-78) SIMPLE APPROXIMATE FORMULA FOR GAMMA STREAMING THROUGH NARROW AIRFILLED OFFSET PENETRATIONS THROUGH REACTOR SHIELDS. Wijker, Hub. (Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands)).

In a homogeneous liquid fuel reactor the circulating fluid is a high γ source. This implies that many shields derive their dimensions from the attenuation of γ radiation instead of from neutron flux attenuation. In this case the γ-streaming through penetrations may play an important part. Once this streaming is known the average exposure rate behind a shield with a number of penetrations can be calculated as well as peak ratios. A simple approximate formula, which gives conservative results, is derived for penetrations with n bends. Results are presented. (5 references) (auth)

13469 (AERE-R-5773(Vol.3), pp 802-33) METHODS OF CALCULATION FOR THE TREATMENT OF SHIELD HETEROGENEITIES IN THE PROTOTYPE FAST REACTOR. Broughton, J. (Nuclear Power Group, Knutsford (England); Butler, J.; Grimstone, M.; Miller, P. C.; Packwood, A. (Atomic Energy Establishment, Winfrith (England)).

The radial shield of the Na-cooled Prototype Fast Reactor is composed of graphite rods enclosed in steel tubes which are arranged in a lattice of seven rows round the periphery of the breeder. The outside diameter of these rods increases by about a factor of 2 between the inner and outer rows; and the interstitial spaces are filled with Na at a temperature of about 600°C. The dimensions of the steel, graphite and Na regions are large compared with the mean free paths of the predominating neutrons at intermediate energies; and homogenization of the shield seriously underestimates the penetration, which is also enhanced by the presence of numerous irregularities associated with nucleonic instrument thimbles, refuelling mechanisms and the primary coolant circuit. Methods of calculation have been developed for the solution of these problems, using both diffusion-theory and Monte Carlo techniques. The diffusion calculations have been accomplished with the COMPRASH and ATTOW codes; and a prototype Monte Carlo code named MOB has been developed, which takes a proper account of the radial shield geometry. The theoretical predictions are compared with measurements made in typical shield arrays on LIDO at Harwell and on the zero-energy fast reactor, ZEBRA, at Winfrith. The diffusion-theory and Monte Carlo approaches are also assessed as design tools taking into consideration accuracy, data preparation and computing time requirements. (5 references) (auth)

13470 (AERE-R-5773(Vol.3), pp 834-57) TREATMENT OF IRREGULARITIES IN SHIELDS. Devillers, C.; Lafore, P.; Lanore, J. M.; Nimal, J. C.; Sivagnanam (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).

Some problems of neutron propagation in shields containing voids have been examined experimentally and theoretically. Some typical problems are described together with a brief account of the experimental arrangement and the codes used to interpret them. These codes use the Monte Carlo method and are adapted to various types of geometry. Neutron propagation in ducts with double bends and in a cylindrical duct blocked by a steel helicoid has been discussed on the basis of the albedo concept with the CUPIDON 2 and TOURNESOL programs. Shields with a regular distribution of voids have been calculated by means of the three dimensional mono-energetic program ZEUS 4. (12 references) (auth)

13471 (AERE-R-5773(Vol.3), pp 904-34) THE TREATMENT OF SHIELD IRREGULARITIES WITH A SPECIALLY DEVELOPED ANALOGUE COMPUTER USING MONTE CARLO TECHNIQUES. McDonald, A. J. G. (English Electric Co., Ltd., Whetstone (England)); Spooner, J. B. (Nuclear Design and Construction Ltd., Whetstone (England)).

A relatively cheap analogue computer (called Nomad 3) has been developed which can readily assimilate complicated geometries and provides an easily usable means of applying Monte Carlo methods to shield design. A brief description is given of the physical basis of the computer. An illustration of the use of the Nomad 3 is given wherein a neutron streaming experiment performed at Harwell was set up, in analogue fashion, on the computer and the two sets of results compared. The results confirm the potential of the Nomad computer as a very useful aid in dealing with complicated geometries and an outline is given of proposed future developments of this technique. (4 references) (auth)

13472 (AERE-R-5773(Vol.4)) PROCEEDINGS OF THE CONFERENCE OF THE PHYSICS PROBLEMS OF REACTOR SHIELDING HELD AT THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, SEPTEMPER 26-29, 1967. (British Nuclear Energy Society, London (England)). May 1968. 334p. (CONF-670932-(Vol.4)). Dep. CFSTI. UK £ 9-8-0 (Vols. 1-5)).

Included are 11 papers on the development of techniques used in reactor shielding design. Experimental results and theoretical calculations on some specific reactor shields are compared, and some of the current shielding design methods are surveyed. Separate abstracts were prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 13350–13354, 13473–13476, 13533, and 13565.

13473 (AERE-R-5773(Vol.4), pp 935-88) NEUTRON TRANSPORT STUDIES IN DUCTS AND SIMPLE SHIELDS: COMPARISON OF MONTE CARLO AND DISCRETE ORDINATES CALCULATIONS WITH EXPERIMENTAL RESULTS FROM THE TOWER SHIELDING FACILITY. Clifford, C. E.; Muckenthaler, F. J.; Maerker, R. E.; Straker, E. A. (Oak Ridge National Lab., Tenn.); Mynatt, F. R. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center).

A development program for neutron transport calculational techniques includes a series of experiments at the Tower Shielding Facility to measure neutron dose distributions in ducts and neutron energy spectra transmitted through simple shields. The experiments were used to guide the development of a simplified Monte Carlo method for calculating neutron transmissions through ducts and to guide the development of the discrete ordinates techniques. Measurements of neutron spectra at specific emergent angles from slab shields of polyethylene and lead were used to verify the discrete ordinates techniques and to aid in the selection of calculational parameters (space, angle and energy meshes, and order of Legendre expansion of the differential scattering cross sections) for use in a two-dimensional code that was developed at Oak Ridge. Cross sections for use in the above neutron transport calculations were selected on the basis of measurements of the uncollided neutron spectra through thick samples of shield materials. (21 references) (auth)

13474 (AERE-R-5773(Vol.4), pp 1098-1123) OPTIMIZATION OF NUCLEAR REACTOR SHIELDING CHARACTERISTICS ON THE BASIS OF VARIATIONAL METHODS. Abagyan, A. A.; Dubinin, A. A.; Kazanskii, Yu. A.; Orlov, V. V.; Petrov, E. E.; Pupko, V. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Fiziko-Energeticheskii Institut).

Methods of optimizing shield composition and shape are considered. The optimization of shield composition is carried out by means of adjoint functions and perturbation theory formulas. On the basis of perturbation theory formulas the concept of a shield material efficiency function with respect to different shielding characteristics is formulated. Shielding material efficiency functions reveal the degree of sensitivity of various shielding characteristics to the variation of shield composition. Experimentally measured efficiency functions for some shielding materials are presented and are compared with calculations. On the basis of the concept of shield material efficiency functions the criteria of optimum shield composition for different cases in classical and non-classical approximations of variational calculus are given. Shield shape optimization is carried out on the basis of the Euler equation. The attenuation of radiation in shielding layers is described by the beam analysis method. The equation obtained for the function describing the form of the shielding is solved by the method of successive approximations. (22 references) (auth)

13475 (AERE-R-5773(Vol.4), pp 1152-72) SOME PROBLEMS OF NEUTRON PENETRATION THROUGH HOMOGENEOUS AND MULTILAYER SHIELDS. **Egorov, Yu. A.; Pankratev, Yu. V.; Veselkin, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow).**

In designing the biological shield of a nuclear reactor, the spatial and energy distribution of the fast neutron flux is of primary importance because in most cases the flux of slowing-down neutrons is determined by the spatial distribution of the fast neutron flux. The removal cross-section method and multigroup treatments in various approximations are widely used to describe the spatial distribution of fast neutrons. The multigroup method in various approximations also makes it possible to determine the spatial distribution slowing-down neutrons. To average the multigroup constants in the energy region of fast neutrons the neutron spectrum in shielding materials and its distortion when the shield thickness is increased or other materials substituted must be known. Such data have been obtained for several media, but only by a calculation method. It is, therefore, of great interest to obtain experimental data on the spectra of fast neutrons after passing through different materials. In recent years measurements have been made for some materials used in reactor engineering. New data from similar investigations are reported and the available experimental results are analyzed. In addition to the exact techniques of shield design, conventional approximate methods are always useful for alternative calculations, especially at the early stages of reactor shield design, when choosing the shield materials and their lay-out. The investigation of the build-up of slowing-down neutrons in various media and shield compositions has enabled the proposed concept of a neutron dose build-up factor to be developed. (16 references) (auth)

13476 (AERE-R-5773(Vol.4), pp 1247-68) METHODS USED IN SHIELDING CALCULATIONS IN THE DESIGN OF POWER REACTORS. **Culambourg, J.; Devillers, C.; Guezenec, J. Y.; Nimal, J. C.; Rastoin, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires).**

Formulas used in shielding calculations for French power reactors are discussed, and problems in the treatment of irregularities in shields are examined. An example of the method used to solve these probelms is presented. The construction of models to allow the development of computing methods and coefficients to be used in the design calculations is shown for high-flux and fast reactors. (9 references) (H.D.R.)

13477 (AERE-R-5773(Vol.5)) PROCEEDINGS OF THE CONFERENCE ON THE PHYSICS PROBLEMS OF REACTOR SHIELDING HELD AT THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, SEPTEMBER 26-29, 1967. (British Nuclear Energy Society, London (England)). May 1968. 179p. (CONF-670932-(Vol.5)). Dep. CFSTI. UK £ 9-8-0 (Vols. 1-5).

Included are 7 papers on methods for the design and performance evaluation of practical reactor shields. Separate abstracts were prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 12950, 13478–13482, and 13566.

13478 (AERE-R-5773(Vol.5), pp 1269-87) PROCEDURE FOR SHIELD OPTIMIZATION. **Enginol, T. B. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht (West Germany). Institut fuer Reaktorphysik).**

The problem of minimization of weight and/or costs of the shielding system, keeping the doses at a given tolerance level with the possible consideration of some further constraints is examined. A method is described, in which an analytical expression is found for approximating the optimal layer thicknesses. This expression is then applied in an iteration procedure. A shielding code is used as a subroutine to determine the dose attenuation properties of the layers at each iteration step. The method is not bound to a particular shielding code and any appropriate code giving the total neutron and γ doses beyond the shield can be used. The optimization program (SHOP) is simple and short so that it does not cause difficulties in using it combined with some detailed shielding code. The structure of the analytically found expressions for the layer thicknesses leads to some conditions for shield materials and an optimum choice and ordering of the materials for a shield synthesis. The method can also be applied to space shielding problems in a similar way. (auth)

13479 (AERE-R-5773(Vol.5), pp 1295-1321) SHIELDING DESIGN OF THE PROTOTYPE FAST REACTOR. **Bonsall, W.; Brindley, K. W. (United Kingdom Atomic Energy Authority, Risley (England). [Reactor Group]); Solari, P. (Nuclear Power Group, Knutsford (England)).**

The neutron and gamma shield configurations of the Prototype Fast Reactor are described, and problems posed by local variations in the neutron shield are discussed. The adequacy of the shield was determined by calculation methods which were compared with measurements on mockups of the shield configuration. The calculation methods employed are described. (H.D.R.)

13480 (AERE-R-5773(Vol.5), pp 1322-45) SHIELD ANALYSIS OF AN EXPERIMENTAL FAST REACTOR. **Dudziak, Donald J.; Battat, M. E. (Los Alamos Scientific Lab., N. Mex.).**

The spatial distribution of neutron and γ-ray energy deposition has been determined for the proposed Los Alamos Molten Plutonium Burnup Experiment. Monte Carlo and point-kernel integration techniques were used to calculate γ-ray transport. Two-dimensional neutron transport calculations were made using both the diffusion-theory and S_4 approximations. Preliminary calculations determined the total γ-ray and neutron energy escape from the reactor vessel and, thus, the reactor room heat load from these sources. More detailed calculations provided values of the absorbed dose at selected locations throughout the reactor system. (20 references) (auth)

13481 (AERE-R-5773(Vol.5), pp 1373-99) EXPERIMENTAL BREEDER REACTOR II SHIELD DESIGN AND PERFORMANCE. **McArthy, A. E.; Kirn, F. S. (Argonne National Lab., Ill.).**

A physical description of the EBR-II shield, a discussion of the shield design including theory, procedures, and calculations, and the results of measurements on the performance of the shield are presented. (8 references) (auth)

13482 (AERE-R-5773(Vol.5), pp 1400-38) METHODS OF CALCULATION FOR THE DESIGN OF INTERNAL AXIAL SHIELDS IN ADVANCED GAS-COOLED REACTORS. **Avery, A. F.; Butler, J.; Miller, P. C. (Atomic Energy Establishment, Winfrith (England)).**

Described is a method of calculation developed for the design of an A.G.R. internal axial shield based on the RASH E code, which is used in conjunction with line-of-sight and iterative-albedo techniques in order to make allowance for neutron streaming in the various ducts and slots penetrating the system of internal shields surrounding the core. An homogenization technique was devised for the helical plugs on the basis of LIDO experiments, and a series of two-dimensional Monte Carlo calculations was carried out to furnish removal cross-sections which may be used with the COMPRASH code in a simplified one-dimensional model for design work. Their accuracy was established by comparing predictions with measurements made on a range of axial shield lattices on LIDO, but the ultimate test of the method is afforded by experimental checks on the prototype shield at Windscale, where it is also necessary to take account of the additional streaming paths which occur in a practical shield design. (6 references) (auth)

Cooling Systems

Refer also to abstract 12128.

13483 (BNWL-933) ACOUSTIC EMISSION DETECTION IN THE PRESENCE OF HYDRAULIC NOISE. **Hutton, P. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 22p. Dep. CFSTI.**

When use of acoustic emission produced as metals deform and fracture is considered as a means of continuously monitoring the integrity of nuclear reactor pressure boundaries, segregation of emission data from background noise must be evaluated. Testing was performed to demonstrate detection of acoustic emission in the presence of turbulent flow and cavitation hydraulic noise. The results show that an acoustic emission sensing system operating in the 1.5 to 2.5 MHz frequency range with shear sensors is essentially insensitive to either turbulent flow or cavitation noise. At the same time, this system will detect acoustic emission signals clearly at a distance of at least 3 ft from the signal source. Follow-on work is necessary to optimize the sensing technique, adapt it to routine field application, and establish the maximum distance at which an acoustic emission signal can be reliably detected. (auth)

13484 (GA-8624) EVALUATION OF CARBON TRANSPORT PHENOMENA IN HTGR SYSTEMS. Burnette, R. D.; Bell, W. E.; Zumwalt, L. R.; Perry, C. A. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 5, 1968. Contract AT(04-3)-167. 40p. Dep. CFSTI.

The results of a technical evaluation of the carbon transport cycle which under certain conditions could occur in a high-temperature, gas-cooled, graphite-moderated reactor (HTGR) are described. The basis of the C transport cycle is that the impurity species H_2O and CO_2 react with the hot graphite in the core, producing CO and H_2 which in turn react at heat exchanger surfaces to form C deposits. Results of the evaluation are summarized. 31 references. (auth)

13485 (LA-tr-68-53) SPECIFIC CHARACTERISTICS OF HEAT TRANSFER IN REACTORS COOLED BY INCOMPRESSIBLE FLUIDS. Osmachkin, V. S. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Proc. Int. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964, 8: 128-39(1965). 34p. Dep. CFSTI.

The results of a theoretical study of specific features of heat exchange processes in the channels of non-compressible liquid-cooled reactors are presented. The possibilities of extending Prandtl's hypothesis about turbulent transfer coefficients to arbitrary flows are discussed. Approximate equations for rate and temperature pulsations in an arbitrary liquid flow are derived from formulas written as integral equations describing the transfer rate and temperature pulsation components. A mathematical analysis of mixing lengths introduced by Prandtl is presented. The problem of stabilized heat transfer and hydraulic resistance in the reactor channels is considered. The approximation of the turbulent viscosity coefficient is used to calculate stabilized heat transfer and hydraulic resistance in tubes and for streamline flows parallel to rod bundles. The results of calculations in a broad range of Reynolds and Prandtl numbers are in good agreement with the available experimental data. The use of the hydraulic diameter for heat transfer and hydraulic resistance calculations is shown to be invalid for the case of streamline flows parallel to bundles of rods. A new method is suggested for determining the equivalent diameter of rod bundles which makes it possible to apply the tube flow formulas for calculating the heat transfer and hydraulic resistance coefficients in rod bundles. Calculations of heat transfer in circular tubes in the initial thermal region and in the sinesection thermal loop are presented. Relaxation length values for the temperature curve are given which help determine heat transfer for an arbitrary thermal loop. The problems of critical thermal loads during surface boiling of heat-transfer agents in the reactor channels and the mechanism responsible for a heat-exchange critical point are discussed. An analytical expression is developed for critical thermal loads for tube flows below boiling point. The equation derived agrees well with the experimental data. (auth)

13486 (ORNL-TM-2405) DYNAMIC ANALYSIS OF A SALT SUPERCRITICAL WATER HEAT EXCHANGER AND THROTTLE USED WITH MSBR. Clark, Francis H.; Burke, O. W. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 43p. Dep. CFSTI.

A linearized, coarse space mesh model of a salt-supercritical water heat exchanger and the downstream throttle was simulated on analog computers. The effects on certain output quantities of changes in certain input quantities were noted. The output quantities were heat exchanger-water outlet temperature and pressure, salt outlet temperature, and enthalpy output. The input quantities were heat exchanger-water inlet temperature and pressure, salt inlet temperature, salt velocity, and throttle setting. Changes were studied only around design steady state. Sufficient input-output data were acquired to permit a greatly simplified representation of these components for further system studies in the neighborhood of design steady state. A tentative scheme of heat exchanger-throttle control was devised to hold water outlet temperature within a 1°F range, and water outlet pressure within a few pounds of design while enthalpy output follows demand. (auth)

13487 PRESSURE LOSSES IN A GAS CIRCULATOR DISCHARGE SYSTEM FOR A NUCLEAR REACTOR. Holmes, N. A.; Sims, G. R. (Atomic Power Constructions Ltd., Middlesex, Eng.) Proc. Inst. Mech. Eng. (London), 182: 5-13(1967-68).

From Conference on Subsonic Fluid Flow Losses in Complex Passages and Ducts, London, England. See CONF-671077.

Trends in reactor design make it necessary to enclose the boilers and gas circulators within the pressure envelope containing the core. In order to reduce the costs of the overall reactor circuit, the volume is kept to a minimum and, unless care is taken in the circuit design, extraneous pressure losses can easily arise. The Dungeness 'B' reactors have four circulators, equi-spaced round the base of a steel cylinder, with the impeller shafts radially disposed. From each circulator the CO_2 gas flows through a conical diffuser into a horizontal duct of varying cross section and up a vertical annulus, via ports in the pressure cylinder, to discharge into a plenum chamber 30 ft above. Pressure loss and flow distribution tests were conducted on a $\frac{1}{4}$ scale model of one quadrant of the reactor layout. Air at atmospheric conditions was used as a working fluid. In all, two designs of ducting and 15 port shapes were tested. The development led to a reduction in pressure loss of some 30% on the original reactor geometry. (auth)

13488 COOLING OF THE DUNGENESS B AGR PRESSURE DOME. Mills, D. (Woolwich Polytechnic, London). Proc. Inst. Mech. Eng. (London), 182: 14-20(1967-68).

From Conference on Subsonic Fluid Flow Losses in Complex Passages and Ducts, London, England. See CONF-671077.

The dome separates the circulator outlet gas at 290°C from the core outlet gas at 675°C and has to operate at a fairly uniform temperature of about 350°C. Penetrating the dome are 465 charge-tubes for fuelling and control of the reactor. The 'cold' gas is used to cool the dome, before passing on to the core re-entry passages. A uniform gas velocity is required over the entire dome surface in the region of the charge-tubes, which involves the radial flow of a large volume of gas over a very complex path. This is achieved by a system of baffles. (auth)

13489 GAS FLOW PASSAGES IN NUCLEAR REACTORS. Lewis, W. E.; Holmes, M. J. (The English Electric Co. Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 182: 21-7 (1967-68).

From Conference on Subsonic Fluid Flow Losses in Complex Passages and Ducts, London, England. See CONF-671077.

The design of flow passages for gas-cooled nuclear reactors is complicated by considerations of nuclear physics and structural design. These difficulties are outlined and experimental work aimed at establishing design criteria for complex ducts of particular shapes is described. Results on the effects of turning vanes and increasing duct width show that conventional procedures for reducing pressure losses in individual bends are not always successful in complex ducts. (auth)

13490 STUDY OF THE FLOW AT INLET TO GAS CIRCULATORS FOR NUCLEAR REACTORS. Lewis, W. E.; Holmes, M. J. (The English Electric Co. Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 182: 28-36(1967-68).

From Conference on Subsonic Fluid Flow Losses in Complex Passages and Ducts, London, England. See CONF-671077.

Experimental work on scale models of the intakes to gas circulators for gas-cooled reactors is described. One model is of a geometry suitable for the older type of reactor in which the boilers are outside the main pressure vessel, while the other is associated with the more recent concrete pressure vessel concept. In both models the flow was through a complex annular bend into the blade annulus in which the flow distribution was measured. In one case the bend was axisymmetric and turned the flow through 180° from one annulus into a concentric inner one. In the other model the geometry was much more complex with flow from a near hemispherical chamber being diverted into the blade annulus by a bend of more than 90° at the top of the intake and 180° at the bottom. The tests showed that the original design of the first model gave a satisfactory performance, but the other model required considerable development work. (auth)

13491 LIQUID METAL FLOW IN A COMPLEX SYSTEM OF PASSAGES. Greene, D. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). Proc. Inst. Mech. Eng. (London), 182: 37-46(1967-68).

From Conference on Subsonic Fluid Flow Losses in Complex Passages and Ducts, London, England. See CONF-671077.

To achieve the necessary flow conditions in a particular liquid metal heat transfer experiment it was necessary to design a rather complex pipework system. An analysis of the system was made, and flow predictions in various parts of the system as functions of valve operation are given. Comparison is made with the experimental results obtained on the rig. The effect of various parameters such as thermal density changes and cavitating flow, caused by large temperature changes and driving pressure heads, is briefly discussed. (auth)

13492 COMPARISON OF 36-ROD CLUSTER PRESSURE-DROP MEASUREMENT WITH PREDICTIONS USING DATA OBTAINED FROM SINGLE RODS. White, L. (United Kingdom

Atomic Energy Authority, Seascale, Eng.); White, W. J. Proc. Inst. Mech. Eng. (London), 182: 47-51(1967-68).

From Conference on Subsonic Fluid Flow Losses in Complex Passages and Ducts, London, England. See CONF-671077.

Most of the data for the type of rough surfaces used in AGR rod clusters have been obtained from annular passages in which the inner surface was roughened and the outer surface was smooth. To apply this data to rod clusters it is necessary to separate the effects of the rough and smooth surfaces. The theory of applying single-rod data to clusters, and a method for predicting rod cluster pressure drop from such data are described. Comparisons are made between predicted and measured cluster pressure loss. Nine sets of rods are tested with roughness in the pitch/height range of 5 to 9.4 and rib heights of 0.009 to 0.013 in. The average discrepancy is 2% and the maximum 5%. (auth)

13493 NUCLEAR REACTOR THERMAL SHIELD AND EXCHANGER SYSTEM. Gerard, C.; Lamproye, F.; Piron, H. (to Societe Anglo Belge Vulcain S. A.). Canadian Patent 798,549. Nov. 5, 1968. Priority date Aug. 27, 1964, Luxembourg.

A pressurized-water reactor has a vertically elongated vessel, a core in the lower portion of the vessel and a pressurizer above the core. This pressurizer is filled with water in its lower part and with steam in its upper part. A partly hollow thermal shield is located around the core and close to the reflector in the vessel. There are means connecting the hollow structure from the lower to the upper part of the pressurizer respectively, in which water is subjected to distillation in the thermal shield using supplementary heat such as a resistance coil. It is thus possible to utilize the heat energy emitted in the thermal shield for evaporating a fraction of the primary water. Branch circuits, heat exchangers, condensation chambers and pumps are also required. (F.S.A.)

13494 PROSPECTS OF WATER COOLING IN HEAVY WATER MODERATED REACTORS. Fonteray, P. J.; Goldstein, S.; Naudet, R. (Commissariat a l'Energie Atomique, Saclay, France). pp 181-5 of Steam Generating and Other Heavy Water Reactors. London, British Nuclear Energy Society, 1968.

From International Conference on Steam Generating and Other Heavy Water Reactors, London, Eng. See CONF-680538.

An assessment is made of the advantages and disadvantages of pressure tube and pressure vessel reactors, and of the alternatives of light and heavy water cooling. Design aspects are discussed by reference to the Canadian reactors. (UK)

13495 CONTAMINATION OF THE PRIMARY CIRCUIT OF THE CHINON REACTOR. Barbier, J. (GRPTO-SPT-EDF, Avoine, France); Houpin, B.; Cordier, G.; Delpla, M. pp 231-8 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968. (In French).

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The principal radioactive elements encountered in the CO_2 coolant of the reactors of the Chinon nuclear power plant are reviewed. Among the activation products, some, such as ^{203}Hg, have a permanent character; others are seen only transitorily. Independently of cladding ruptures, there are always fission products in the CO_2. The indirect measurement of this circuit contamination using ^{134}Cs is described. (tr-auth)

Fuels

Refer also to abstracts 11672, 11673, 12302, and 12388.

13496 (AERE-R-5773(Vol.2), pp 554-70) NEUTRON ATTENUATION IN A COMPACT SHIELD. Buscaglione, S. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo); Culambourg, J.; Edeline, J. C.; Lott, M.; Rastoin, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Schmitt, A. P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

Fast-reactor shielding involves material such as graphite, borated graphite, steel and Na in a heterogeneous form, for example graphite elements canned in stainless steel in Na. In order to assess the effect of heterogeneity which is not taken into account in the initial calculations, it is necessary to arrange the problems in order of increasing difficulty: attenuation in homogeneous medium, attenuation in a series of homogeneous media, attenuation in actual media (for example cylindrical rods in Na). The first stage is described in this report. The materials considered are graphite, borated graphite with 5% natural B by weight, and steel. The NIOBE and MAC-RAD programs were used for comparisons between calculation and experiment. Some considerations concerning the use of these programs for calculation of fast reactor shielding are discussed. (4 references) (auth)

13497 (AI-AEC-12721, pp 161-3) FBR FUEL CLADDING AND STRUCTURAL MATERIALS. Atkins, D. F. (Atomics International, Canoga Park, Calif.).

Purchasing requirements are presented for fuel element cladding tubes of Type 304 stainless steel, Type 316 stainless steel, Incoloy 800, and Inconel 625. (D.C.C.)

13498 (AI-AEC-12721, pp 165-84) FBR FUEL CLADDING AND STRUCTURAL MATERIALS. Atkins, D. F. (Atomics International, Canoga Park, Calif.).

The effects of Na and helium environment, strain rate, and uniaxial and biaxial stress conditions on creep, stress rupture, and fatigue characteristics of Type 304 and Type 316 stainless steel tubes are described. (D.C.C.)

13499 (AI-AEC-12721, pp 243-54) FBR FUEL DEVELOPMENT, FUEL CLADDING, AND STRUCTURAL MATERIALS. Shively, J. H. (Atomics International, Canoga Park, Calif.).

The effects of injected He on the tensile properties of thin-walled Type 304 stainless steel and Type 316 stainless steel tubes are described. (D.C.C.)

13500 (AI-AEC-12721, pp 255-60) FBR FUELS AND CLADDING. Ervin, G. Jr. (Atomics International, Canoga Park, Calif.).

The carbon activities in PuC - UC reactor fuels are analyzed. (D.C.C.)

13501 (ANL-7475) URANIUM NITRIDE-SODIUM PASTE FUEL FOR FAST-REACTOR BLANKETS. Nelson, P. A.; Chasanov, M. G. (Argonne National Lab., Ill.). Aug. 1968. Contract W-31-109-eng-38. 36p. Dep. CFSTI.

An evaluation of various fluid fuels for fast-reactor blankets indicated that a paste of UN particles in a Na vehicle is the most attractive. This fuel concept might save 0.06 to 0.07 mill/kW-hr or about 20% of the total blanket costs, including the costs of removing and shuffling fuel, coolant inefficiency, fuel fabrication, and fuel reprocessing. To support the conclusions of the evaluation study, a UN-Na paste of 49 v/o solids was prepared and shown to be compatible with a Type 304 stainless steel container. Paste-flow measurements and Na-wetting experiments also indicated the feasibility of this fuel concept. 37 references. (auth)

13502 (BNWL-SA-1979) PLUTONIUM RECYCLE FUEL EVALUATIONS AT PNL. Freshley, M. D.; Burley, T. B.; Goldsmith, Stanley (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1968. Contract AT(45-1)-1830. 29p. (CONF-681101-10). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Powder and pellet mixed-oxide thermal recycle fuels are performing well in PRTR under high power density conditions. Results of this program to date are very satisfactory, and no unexpected problems have been encountered with maximum fuel temperatures near melting. Specific powers and burnups are being pushed higher as rapidly as possible to provide needed thermal recycle fuel performance data at conditions planned for future power reactors now being committed. Goal peak burnups are 50,000 MWd/MTM. Postirradiation examination results on vibrationally compacted PuO_2-UO_2 fuels with peak burnups in the range of 10,000 MWd/MTM are in conformance with the expected behavior. Gas pressure buildup measurements indicate that the actual internal gas pressure in mixed-oxide fuel rods undergoing irradiation at high specific powers is less than the maximum pressures expected. The fission gas release fraction, however, is as expected up to the peak burnup level of 10,000 MWd/MTM. The defect behavior of different type mixed-oxide fuels is being evaluated in the Fuel Element Rupture Test Facility (FERTF). Calibration tests with nondefected rods show that actual rod-to-rod power variations in the FERTF test element may be within ±1%, as determined by gamma scanning. Rod-to-rod power variations, as determined by structural changes in the fuel, can only be estimated to within ±5%. 13 references. (auth)

13503 (GA-6532) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report for the Quarter Ending June 30, 1965. (Gulf General Atomic, Inc., San Diego, Calif.). July 30, 1965. Contract AT(04-3)-187. 95p. Dep. CFSTI.

BERYLLIUM OXIDE REACTOR EXPERIMENT—fuel elements for, development of optimum-shaped pellets of silicon carbide (SiC)-clad beryllium oxide (BeO)-thorium oxide (ThO_2)-uranium oxide (UO_2)

BERYLLIUM OXIDES—$BeO-ThO_2-UO_2$, effects of burnup and temperature on gaseous fission product release from fuel matrix in GA4-F5 capsule containing

—BeO–ThO_2–UO_2, radiation effects on physical properties of isostatically pressed and sintered, analysis of neutron

—BeO–ThO_2–UO_2, fission product release from pellet-type fuels of, effects of fabrication processes on

—BeO–PuO_2–ThO_2, fuel cycle for, analysis of optimum economic, (T)

—BeO–ThO_2–UO_2, fuel elements for EBOR of, development of optimum-shaped pellets of silicon carbide (SiC)-clad rod-type

FISSION PRODUCTS—release from beryllium oxide–thorium oxide (ThO_2)–uranium oxide (UO_2) pellet-type fuels, effects of burnup, temperature, and fabrication methods on

GRAPHITE—tensile properties of SX-4 and H-315-A, comparison of

—diffusion of lithium-6 in HLM-85, analysis of

KRYPTON ISOTOPES Kr-85—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

KRYPTON ISOTOPES Kr-87—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

KRYPTON ISOTOPES Kr-88—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

LITHIUM ISOTOPES Li-6—diffusion in HLM-85 graphite, analysis of

NEUTRONS—effects on physical properties of isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel

PLUTONIUM OXIDES PuO_2—BeO–PuO_2–ThO_2, fuel cycle for, analysis of optimum economic, (T)

REACTOR FUEL ELEMENTS—radiation effects on physical properties of beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2), analysis of neutron

—development of optimum-shaped pellets of silicon carbide (SiC)-clad beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) for rod-type

REACTOR FUELS—fission product release from GA4-F5 capsule containing beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2), effects of burnup and temperature on gaseous

—fission product release from beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2), effects of fabrication processes on

—cycle for beryllium oxide (BeO)–plutonium oxide (PuO_2)–thorium oxide (ThO_2), analysis of optimum economic, (T)

SILICON CARBIDES—cladding of fuel pellets of beryllium oxide-matrix thorium oxide (ThO_2)–uranium oxide (UO_2), development for EBOR rod-type fuel elements of

THORIUM OXIDES ThO_2—BeO–ThO_2–UO_2, effects of burnup and temperature on gaseous fission product release from fuel matrix in GA4-F5 capsule containing

—BeO–ThO_2–UO_2, radiation effects on physical properties of isostatically pressed and sintered, analysis of neutron

—BeO–ThO_2–UO_2, fission product release from pellet-type fuels of, effects of fabrication processes on

—BeO–PuO_2–ThO_2, fuel cycle for, analysis of optimum economic, (T)

—BeO–ThO_2–UO_2, fuel elements for EBOR of, development of optimum-shaped pellets of silicon carbide (SiC)-clad rod-type

URANIUM OXIDES UO_2—BeO–ThO_2–UO_2, effects of burnup and temperature on gaseous fission product release from fuel matrix in GA4-F5 capsule containing

—BeO–ThO_2–UO_2, radiation effects on physical properties of isostatically pressed and sintered, analysis of neutron

—BeO–ThO_2–UO_2, fission product release from pellet-type fuels of, effects of fabrication processes on

—BeO–ThO_2–UO_2, fuel elements for EBOR of, development of optimum-shaped pellets of silicon carbide (SiC)-clad rod-type

XENON ISOTOPES Xe-133—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

XENON ISOTOPES Xe-135—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

XENON ISOTOPES Xe-138—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

XENON ISOTOPES Xe-139—release from isostatically pressed and sintered beryllium oxide (BeO)–thorium oxide (ThO_2)–uranium oxide (UO_2) fuel, effects of burnup, temperature, and fabrication method on

13504 (GA-6742) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report for the Quarter Ending September 30, 1965. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 31, 1965. Contract AT(04-3)-187. 90p. Dep. CFSTI.

BERYLLIUM ISOTOPES Be-7—diffusion in HLM-85 graphite, measurement of

BERYLLIUM OXIDE REACTOR EXPERIMENT—fuel element assemblies for, development of silicon carbide (SiC)-clad beryllium oxide (BeO)-matrix thorium oxide (ThO_2)–uranium oxide (UO_2)

BERYLLIUM OXIDES—fuel matrix of, effects of fabrication processes on performance of plutonium and thorium

—BeO–SiO_2, fuel matrix of, effects of fabrication processes on fission product retention in uranium oxide (UO_2)

—fuel matrix of, development of EBOR thorium oxide (ThO_2)–uranium oxide (UO_2)

CESIUM ISOTOPES Cs-137—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuel, effects of fabrication processes on

FISSION PRODUCTS—retention of, effects of fabrication processes on beryllium oxide (BeO)-matrix thorium oxide (ThO_2)–uranium oxide (UO_2) pellet-type fuel

—retention in beryllium oxide (BeO)–silicon oxides (SiO_2)-matrix uranium oxide (UO_2) pellet-type fuel, effects of fabrication processes on

GRAPHITE—tensile properties of silicon carbide (SiC)-coated, effects of air at 1000°C on

—diffusion of beryllium 7 in HLM-85, measurement of

IODINE ISOTOPES—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuel, effects of fabrication processes on

KRYPTON ISOTOPES Kr-85—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuels, effects of fabrication processes on

KRYPTON ISOTOPES Kr-87—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuels, effects of fabrication processes on

KRYPTON ISOTOPES Kr-88—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuels, effects of fabrication processes on

KRYPTON ISOTOPES Kr-89—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuels, effects of fabrication processes on

PLUTONIUM ISOTOPES Pu-239—neutron cross sections for, calculation of effective

PLUTONIUM ISOTOPES Pu-240—neutron cross sections for, calculation of effective

PLUTONIUM ISOTOPES Pu-241—neutron cross sections for, calculation of effective

PLUTONIUM ISOTOPES Pu-242—neutron cross sections for, calculation of effective

REACTOR FUEL ELEMENTS—assemblies of EBOR, development of silicon carbide (SiC)-clad beryllium oxide (BeO)-matrix thorium oxide (ThO_2)–uranium oxide (UO_2) rod-type

REACTOR FUELS—utilization of beryllium oxide (BeO)-matrix plutonium and thorium, effects of fabrication processes on

SILICON CARBIDES—coating of graphite of, effects of air at 1000°C on

—cladding of, development for EBOR beryllium oxide (BeO)-matrix thorium oxide (ThO_2)–uranium oxide (UO_2) rod-shaped fuel element of

SILICON OXIDES—BeO–SiO_2, fuel matrix of, effects of fabrication processes on fission product retention in uranium oxide (UO_2)

TELLURIUM ISOTOPES Te-132—retention in uranium oxide (UO_2) pellet-type beryllium oxide (BeO)–silicon oxide (SiO_2)-matrix fuel, effects of fabrication processes on

THORIUM OXIDES ThO_2—ThO_2–UO_2, fuels of beryllium oxide (BeO)-matrix pellet-type, effects of fabrication processes on fission product retention in

—ThO_2–UO_2, fuel assemblies for EBOR of, development of silicon carbide (SiC)-clad beryllium oxide (BeO)-matrix rod-type

URANIUM OXIDES UO_2—fuels of beryllium oxide (BeO)–silicon oxides (SiO_2)-matrix pellet-type, effects of fabrication processes on fission product retention in

—ThO_2–UO_2, fuel assemblies for EBOR of, development of silicon carbide (SiC)-clad beryllium oxide (BeO)-matrix rod-type

—ThO_2–UO_2, fuels of beryllium oxide (BeO)-matrix pellet-

type, effects of fabrication processes on fission product retention in
XENON ISOTOPES Xe-135—retention in uranium oxide (UO$_2$) pellet-type beryllium oxide (BeO)–silicon oxide (SiO$_2$)-matrix fuel, effects of fabrication processes on
XENON ISOTOPES Xe-138—retention in uranium oxide (UO$_2$) pellet-type beryllium oxide (BeO)–silicon oxide (SiO$_2$)-matrix fuel, effects of fabrication processes on
XENON ISOTOPES Xe-139—retention in uranium oxide (UO$_2$) pellet-type beryllium oxide (BeO)–silicon oxide (SiO$_2$)-matrix fuel, effects of fabrication processes on

13505 (UNC-5225) EXPERIMENT DESCRIPTION AND HAZARDS ANALYSIS FOR CAPSULES UNC 191 THROUGH UNC 209: NINETEEN EXPERIMENTAL (UPu)C-FUELED EBR-II RODS. Rich, B.; Rutland, L. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Oct. 1, 1968. Contract AT(30-1)-3415. 77p. Dep. CFSTI.

The hazards analysis for 19 individually encapsulated PuC–UC fuel rods is presented. The 19 capsules, designated UNC 191 through UNC 209, are evaluated for performance in EBR-2 subassembly location 3N1. 15 references are included. (D.C.C.)

13506 (WCAP-3269-23) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, July 1–September 30, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT-(30-1)-3269. 21p. Dep. CFSTI.

The in-pile performances of Zircaloy-clad fuel rods exposed to fast neutrons and borated pressurized-water in the Saxton Power Reactor are described. The clad samples include: Zircaloy-2; and nickel-free Zircaloy-2 and Zircaloy-4. Fuel-swelling studies for pin-type UO$_2$ are described. (D.C.C.)

13507 A NOTE ON EQUILIBRIUM FUEL CYCLE ANALYSIS. Blomstrand, J. H. (Atomic Energy Establishment, Winfrith, Eng.). J. Nucl. Energy, 22: 687-97(Nov. 1968).

The equations governing the physics performance of the equilibrium fuel cycle in breeder reactors, refueled on-load, are normally solved by iterative techniques. In certain circumstances, however, a direct analytical method may be used, which is valid for a large variety and complexity of fuel management schemes. Application of the method to numerical evaluation on digital computers gives short running times and is therefore of special interest for parametric studies. (auth)

13508 USE OF FUELS IN UKAEA FOR NUCLEAR ENERGY. Manning, R. B. Elektrotech. Maschinenbau, 85: 252-4(May 1968). (In German).

Uranium enrichment and preparation in the UKAEA are discussed. Fuel element production is described. (M.L.S.)

13509 SPECIAL PROBLEMS OF AN EXTERNAL FUEL CYCLE OF A NUCLEAR POWER PLANT. Jelinek-Fink, Peter. Elektrotech. Maschinenbau, 85: 250-2(May 1968). (In German).

The management problems associated with the handling of spent fuel are discussed. Reprocessing and shipping problems are outlined; economic effects are considered. Pu recycling is discussed briefly. (M.L.S.)

13510 COMPARATIVE POSITION OF THE MAIN FUELS IN CANADA. Charbonnier, R. P. (Dept. of Mines and Technical Surveys, Ottawa); Baltzer, C. E.; Simpson, R. A. pp 2208-25 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.
See CONF-661066(Vol.4).

The primary energy sources in Canada are compared first in terms of estimated regional reserves of coal, oil, gas, nuclear, and water power. The statistical trends in utilization of the various energy resources for the generation of electricity are analyzed. The estimated costs of electricity, produced from the main energy sources, and delivered at various distances, by different methods of transportation, are compared. (auth)

13511 THE EFFECTS OF AN EXPANDING NUCLEAR POWER PROGRAMME ON THE PRODUCTION OF NUCLEAR FUELS IN THE UNITED KINGDOM. Hill, J. M.; Allday, C. pp 2194-2207 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.
See CONF-661066(Vol.4).

The program of reactor development and nuclear power station construction being undertaken in the United Kingdom is reviewed with particular reference to the associated fuel cycle. In this program complementary reactor systems are introduced progressively. The first stage was based on reactors of the Calder Hall type using natural uranium. The second stage of the program is based on gas cooled reactors using slightly enriched uranium oxide clad in stainless steel. The final stage of the program will be directed towards the introduction of fast reactors using plutonium produced from the earlier systems. The fuel service required to support a program of complementary reactors is discussed with particular relation to the three factories of the Atomic Energy Authority at Springfields, Capenhurst and Windscale. These three factories are operated as an integrated unit providing the manufacture of natural uranium fuel elements, the enrichment of uranium, the manufacture of enriched uranium fuel elements and the manufacture of plutonium/uranium fuel elements for the fast reactor. The combined resources of the factories also provide the facilities for recovery of plutonium and uranium from irradiated fuels and the re-enrichment of the partially used uranium. This unique assembly of nuclear fuel facilities enables a complete nuclear fuel service to be provided for the United Kingdom nuclear power program and the resources of these factories are available on a worldwide basis either to provide a complete fuel service or to provide any part of that fuel service required by reactor operators. (auth)

13512 15th SECTIONAL MEETING OF THE WORLD POWER CONFERENCE, TRANSACTIONS, TOKYO, 16–20 OCTOBER 1966. VOLUME IV. Tokyo, Japanese National Committee, World Power Conference, 1966. 629p. (In English and French). (CONF-661066(Vol.4)).

Included are 39 papers on the interrelation of electrical power systems and on the comparative position of principal fuels in worldwide energy production. Separate abstracts were prepared for 8 papers on the integration of nuclear reactors in power systems and on the economic aspects of nuclear fuel production and utilization. (H.D.R.)

For abstracts of individual papers see: 11620, 11621, 13432, 13433, 13510, 13511, 13513, and 13517.

13513 PAST AND FUTURE OF THE CHANGE IN THE COMPARATIVE POSITION OF MAIN FUELS IN JAPAN. Oshima, K. (Tokyo Univ.). pp 2269-89 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.
See CONF-661066(Vol.4).

The primary sources of energy supply in Japan from 1860 to the present are reviewed. Trends of future utilization of fuels are surveyed, especially regarding the increased use expected for oil and nuclear fuel. (H.D.R.)

13514 BALANCE OF THE FUEL DEMAND FOR A 10000 MWel PROGRAM WITH DOR-TYPE REACTORS. Korsova, Marta; Machacek, Vojtech (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 14: 425-31(Dec. 1968). (In Czech).

The evolution in time of both production capacities and related capital costs necessary to secure nuclear fuel supplies as required by a hypothetical realization of a 10,000 MW(e) nuclear power program with DOR reactors (heavy water moderated, organic cooled, natural UC fueled) is analyzed. The particular procedures are estimated in a chain from the ore extraction to the production of complete fuel assemblies, and finally, the respective plant capacities together with their capital costs are set up in the tables in correspondence with the commissioning years. All costs are expressed in U.S. dollars with reference to published data on similar facilities abroad. The study possesses a methodical character; nevertheless, it indicates that the program in question represents a final total production capacity of about 1100 metric tons of UC fuel elements per year which may be realized in the considered extent and structure at approximate capital costs of $5.7 U.S. per kW(e). (auth)

Auxiliary and Emergency Systems

13515 (AI-AEC-12721, pp 155-60) FBR FUEL CLADDING AND STRUCTURAL MATERIALS. Murbach, E. W. (Atomics International, Canoga Park, Calif.).

Topics discussed include: Na supply loop; Na dispensing; Na sampling; and oxygen meter studies. (D.C.C.)

13516 THERMAL STRESSES OF TRANSIENT PARTS OF THE REACTOR OUTLET TUBING IN THE CASE OF THERMAL SHOCKS. Kunes, Josef; Svigler, Vladimir; Vavroch, Otakar (Technical Univ., Plzen, Czech.). Jad. Energ., 15: 15-21(Jan. 1969). (In Czech).

The problem of the unsteady temperatures, temperature-gradients and thermoelastic stresses in the conical jacket of the gas-outlet piping with variable wall thickness is described. The temperature and temperature-gradient variations are worked out on a modified Beuken R-C analogue, while the thermoelastic stresses are evaluated by means of a digital computer. The solution covers the variability of the inner wall of the jacket, and provides for four alternative courses in time of the temperature of the flowing gas. (auth)

Operation and Economics

Refer also to abstracts 11620 and 13560–13563.

13517 THE INTEGRATION OF NUCLEAR UNITS IN POWER SYSTEMS INVESTMENT DECISIONS UNDER UNCERTAINTY. Malmloew, E. G.; Ryman, J. E. pp 1780-92 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. IV. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066(Vol.4).

With nuclear power now commercially competitive it has become a paramount problem to evaluate properly when and to what extent nuclear units should be added to existing power production systems in order to minimize the future cost of generation. This need for a more thorough analysis before investment decisions are made is strengthened to a considerable degree by the fact that nuclear power is new and thus involves an additional number of uncertain factors. With several types of potential power sources available it is also necessary to plan well ahead by means of an investigation of various alternative sequences of decisions. An attempt is made to outline in principle such a comprehensive method of analysis, building on the considerable work already carried out in Sweden in this field. In order to illustrate some aspects of its potential usefulness, the method is first simplified to a considerable degree, making it easily manageable on an available computer, and then exemplified by a numerical case, designed to reflect conditions in a hypothetical power company. (auth)

13518 NUCLEAR POWER IN THE UNITED STATES: STATUS AND OUTLOOK. Vallance, J. M. (Atomic Energy Commission, Washington, D. C.). pp 1603-24 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

Speculative long range trend projections of the fuel cost of a light water reactor are developed. Besides varying the prices for fuel fabrication and spent fuel recovery, three separate trends in the price of enriched uranium were assumed. Case I assumes that natural uranium continues to be available at \$5/lb U_3O_8 and that the price of separative work declines from \$30 to \$20/KgU. Case II assumes that the price of natural uranium climbs to and stays at \$8/lb U_3O_8 and that separative work declines to \$25/KgU. Case III assumes that natural uranium gradually increases to \$12/lb U_3O_8 and that separative work remains at the current \$30/KgU level. In calculating the resulting fuel costs, present worth factors (discount rate of 6%/year) were employed. Thus, the results are given as levelized plant lifetime fuel costs. Annual carrying charges on the average investment in the nuclear fuel cycle were taken as 10%. For the lower of the two sets of cost data used to represent fabrication and spent fuel recovery, the resulting fuel costs are given. One set of results applies to a light water reactor which begins service in 1970. The other set applies to a plant which begins service in 1975. (auth)

Safety and Siting

13519 (AI-AEC-12721) AEC UNCLASSIFIED PROGRAMS. Annual Technical Progress Report, Fiscal Year 1968. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. 381p. Dep. CFSTI.

Separate abstracts are included for all of the 29 sections presented. (D.C.C.)

For abstracts of individual papers see: 11478, 11479, 11528, 11941, 12295, 12698, 12955, 13402–13408, 13440, 13497–13500, 13515, 13520–13523, 13534–13537, and 13582.

13520 (AI-AEC-12721, pp 83-109) REACTOR DEVELOPMENT. Silberberg, M.; Guon, J.; Zwetzig, G. (Atomics International, Canoga Park, Calif.).

The behavior of fission products released to the coolant in a fast, Na-cooled, LMFBR reactor during normal operation is analyzed. Topics discussed include: typical fast breeder reactor characteristics; radioisotope flow chart; radiological hazards index; radiation index; relative concentration of fission products and corrosion-activation products; source term model formulation; vaporization experiments; deposition and trapping studies; fission product behavior loop; and LMFBR system behavior. (D.C.C.)

13521 (AI-AEC-12721, pp 111-29) REACTOR DEVELOPMENT. Koontz, R.; Nelson, C.; Baurmash, L.; Johnson, R.; Greenfield, M.; Hopenfeld, J.; Silberberg, M.; Hausknecht, D. (Atomics International, Canoga Park, Calif.).

Analytical methods which characterize the release and transport of effluents and energy generated during a primary-coolant-sodium accident are described. The information obtained from the analytical methods will be used for design and safeguards analysis of fast Na-cooled reactors. Topics discussed include: laboratory test chamber studies of Na and UO_2; spray fires; large fundamental fires; data reduction codes; transient Na burning model; SOFIRE computer program; and aerosol behavior. (D.C.C.)

13522 (AI-AEC-12721, pp 149-53) LIQUID METAL FAST BREEDER REACTOR TECHNOLOGY. Sturtevant, W. C. (Atomics International, Canoga Park, Calif.).

The deactivation and "store-in-place" operations for the SRE are described. (D.C.C.)

13523 (AI-AEC-12721, pp 309-12) HNPF. Ureda, B. F. (Atomics International, Canoga Park, Calif.).

The retirement procedures for the Hallam Power Reactor are described. (D.C.C.)

13524 (BNWL-944) MELT-I: A SIMPLIFIED MELTDOWN CODE FOR FAST REACTOR SAFETY ANALYSIS. Waltar, Alan E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 161p. Dep. CFSTI.

MELT-1 is a coupled neutronics-heat transfer code for use in estimating gross core behavior during major fast reactor excursions. The unique feature of the code is the treatment of positive reactivity feedbacks due to fuel collapse and Na voiding. Although the feedback models and the method of obtaining core temperatures are quite simplified, the ability of the code to couple the feedback terms to the driving function in the point kinetics equations allows one to make reasonable estimates of core conditions just prior to the start of core disassembly. The core model consists of a maximum of 10 radial channels, 40 axial segments, and 8 radial fuel nodes plus a clad and a coolant node for each pin. Running time, although highly problem dependent, is roughly three minutes for a representative case on a UNIVAC 1108. All programming is in FORTRAN-4. (auth)

13525 (ORNL-NSIC-54) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-16. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 304p. Dep. CFSTI.

The indexed bibliography of current nuclear safety is presented. Bibliographic items are sorted into the following categories: General Safety Criteria; Siting of Nuclear Facilities; Transportation and Handling of Radioactive Materials; Aerospace Safety; Accident Analysis; Reactor Transients, Kinetics, and Stability; Fission Product Release, Transport, and Removal; Sources of Energy Release Under Accident Conditions; Nuclear Instrumentation, Control, and Safety Systems; Electrical Power Systems; Containment of Nuclear Facilities; Plant Safety Features; Radiochemical Plant Safety; Radionuclide Release and Movement in the Environment; Environmental Surveys, Monitoring and Radiation Exposure of Man; Meteorological Considerations; Operational Safety and Experience; Safety Analysis and Design Reports; and Bibliographies. (D.C.C.)

13526 SAFETY REVIEWING OF THE ATOMIC ENERGY ESTABLISHMENTS IN THE FEDERAL REPUBLIC OF GERMANY. Kellermann, Otto. Elektrotech. Maschinenbau, 85: 235-8(May 1968). (In German).

The regulatory processes of the Federal Republic of Germany are described. Legislative basis is discussed; the regulatory organization and its functions are outlined. The accident analyses, which serve as a basis for technical safety assurance, are discussed; quality control during construction and in-service surveillance are discussed, use of the testing and surveillance results is mentioned. (M.L.S.)

13527 SAFETY OF NUCLEAR POWER PLANTS. Gruemm, Hans. Elektrotech. Maschinenbau, 85: 225-35(May 1968). (In German).

A survey of the consequences, principles, methods, status, and trends in reactor safety techniques is given. The safety record of nuclear power plants is examined; the danger potential of reactors is considered. Principles of reactor safety techniques are reviewed. Types of reactor accidents which are considered as severe are described; the various types of containment systems are considered. The safety philosophies of the US and England are discussed. 29 references. (M.L.S.)

13528 THE MAIN FACTORS AFFECTING THE NUCLEAR POWER REACTOR SITE SELECTION IN FINLAND. Vapaavuori, O.; Jahkola, A. pp 1528-44 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

The effect of various site selection factors on nuclear power generating cost in Finland is discussed. It is indicated that the additional cost which safety requirements might cause in construction of a nuclear power plant, is by no means conspicuous compared with other factors. It is noted that the location of a nuclear power plant far from population centers merely on the ground of matters of sentiment, may result in an essential increase in power generating cost. Today the safety aspects may be considered to be only one of several cost factors which have to be evaluated in searching for the optimum site. (auth)

13529 FACTORS AFFECTING THE CHOICE OF SITES FOR NUCLEAR POWER STATIONS. Mandel, H. (Elektrizitaetswerk AG, Essen). pp 1507-27 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. III. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.3).

The technical and economic importance of geological conditions, meteorological conditions, geographical location, hydrology, and location with respect to extra-high-voltage network in the selection of a site for a nuclear power station is examined. The possibilities of making an economically optimum site selection are shown to be largely dictated by the availability of an adequate water supply and the proximity of load centers or a supply network. (H.D.R.)

13530 HEALTH PHYSICS EXPERIENCE IN THE OPERATION AND MAINTENANCE ON AN ON-LOAD REFUELLING PROGRAMME ON UNITED KINGDOM CIVIL POWER REACTORS. Emmerson, B. W.; Dennett, M. (Central Electricity Generating Board, Southminster, Eng.). pp 239–51 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

On-load refuelling, an inherent factor in the design of the United Kingdom Civil Power Reactors, was first carried out at Bradwell Power Station in April 1963. Although information regarding dose rates around the charge/discharge machine had been measured during the movement of the active absorber material to and from the core, this did not simulate the effect of the delayed neutron spectrum from freshly withdrawn, irradiated fuel, nor could this effect be calculated with any degree of certainty. Shielding surveys were made using conventional γ dose rate measuring instruments, while the more complex neutron dose contribution was assessed using BF$_3$ counters, Basson intermediate energy detectors, proton recoil counters, and the Andersson–Braun rem counter. At full power, the dose rate from a fuel element being withdrawn from the reactor was measured and the decay curve plotted. The dose rate due to the delayed neutron fraction was shown to decay almost completely within two minutes of withdrawing the element from the neutron flux. Although measurements inside the shielding close to the fuel element guide tube indicated peak dose rates up to 10^5 R/h, the results of the on-load fuel handling program show that the delayed neutron contribution, although significant, does not limit access to the reactor pile cap during discharge of fuel at full reactor power. Occupational exposure associated with on-load fuel handling results mainly from activation of various charge machine components. Experience in limiting the accrued dose to maintenance personnel repairing activated fuel handling grabs is discussed in detail, while the use of film and thermoluminescent dosimeters for dose control has allowed work to be undertaken on relatively high dose rate components with confidence. The need for a more accurate beta sensitive monitoring device for this type of work is emphasized. The health physics requirements associated with ancillary fuel handling facilities are discussed together with experience in the recovery of damaged irradiated fuel from a charge machine and subsequent decontamination procedures. The need for an integrated approach to the design of fuel handling plant and the associated reactor ancillary equipment is stressed. (auth)

13531 MEASUREMENT OF TRITIUM IN AIR IN THE PRESENCE OF GAMMA RADIATION. Cowper, G.; Osborne, R. V. (Chalk River Nuclear Labs., Ont.). pp 285–93 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920–(Vol.1).

A high flux heavy water reactor produces T copiously. Since leakage of heavy water from the moderator or the coolant circuit will lead to tritiated water vapor in neaby air in possibly hazardous concentrations, a means for measuring T in air is needed. Often such measurements have to be made in places where there are also significant levels of γ radiation so the detecting device must be capable of distinguishing between the low energy β from T and γ radiation. The extent of this problem is illustrated by the fact that 1 (MPC)$_a$ of T produces only as much ionization in air as a γ radiation field of 50 μR per hour. Another important aspect of the problem is that the concentration of T in air may lie within very wide limits depending upon the particular circumstances of the release. Several methods have been developed to meet this requirement using large γ-compensated ionization chambers for installed area monitors, small volume compensated chambers complete with battery operated electrometers for portable use and scintillation detectors which achieve discrimination in favor of T by special circuit techniques. The design of these devices and their application in the Canadian heavy water program are discussed. (auth)

Research and Test Reactors

Refer also to abstracts 11705, 11924, 12266, 12945, 13409, and 13519.

13532 (AERE-R-5773(Vol.2), pp 571-96) COMPARISON OF MEASUREMENTS AND CALCULATIONS OF THE NEUTRON SPECTRUM IN LIDO EXPERIMENTAL SHIELDS. Grimstone, M.; Miller, P. C.; Packwood, A. (Atomic Energy Establishment, Winfrith (England)); Silk, M. (Atomic Energy Research Establishment, Harwell (England)); Redfearn, J. (Atomic Weapons Research Establishment, Aldermaston (England)); Hatton, D. (Birmingham Univ. (England)).

The spectrum is measured behind a 12 inch-thick slab of steel followed by graphite and Na shield regions, in order to demonstrate the filter technique used for simulating the leakage spectrum of a fast reactor in the LIDO facilities. Measurements are also being made in a series of typical configurations to establish the accuracy of neutron spectrum predictions for pressure vessel damage estimates in various power reactor designs. The Monte Carlo calculations are being carried out with the new S2 Fortran version of the McNID code, and the accuracy is determined primarily by nuclear data errors and the representation of the core the shield system in two-dimensional cylindrical polar co-ordinates. A statistical accuracy of about 15% can be achieved with computing times of the order of 5 hours on the IBM 7030 machine. The calculations generally agree with the experimental results within the estimated errors for energies above about 50 keV, but some discrepancies have been found at lower energies. (16 references) (auth)

13533 (AERE-R-5773(Vol.4), pp 1045-68) STORAGE SHELTER FOR BR3 IRRADIATED VESSEL INTERNALS. Pilate, S. (Societe Belge pour l'Industrie Nucleaire, Brussels).

Theoretical and experimental results are compared for the BR3 storage shelter for irradiated vessel internals, which comprises mainly a shielding wall consisting of lead pillars, steel supported and clad, assembled together and fixed on a concrete socle, with a steel jacket covering the top of the pillars. Various steps were involved in the calculation of the shielding wall thickness and shape. The map of neutron fluxes within the pressure vessel of the BR3 reactor during operation was established by means of the removal diffusion technique. γ sources in the steel internals were derived, allowing for the calculation of γ dose rates, due either to direct transmission through the shielding, or to streaming along the various gaps. Two kinds of dose rate measurements were taken when the internals were introduced in the shelter; the first ones, remotely at the surface of the internals, and the second ones at the external surface of the shielding wall enclosing all the pieces. The measurements showed a satisfactory agreement with the theoretical predictions. In particular the direct transmission of photons was fairly well predicted. The dose rates due to radiation streaming were somewhat conservatively estimated. Results of calculations were on the safe side. (6 references) (auth)

13534 (AI-AEC-12721, pp 29-41) CIVILIAN POWER, LMFBR. Springer, T. H.; Tuttle, R. J.; Royden, H. N. (Atomics International, Canoga Park, Calif.).

Four different test regions in the ECEL were studied. Characteristics of the test regions are listed. Calculations and measurements made in Cores 14 to 17 include: heated-blanket Doppler effect; flux spectra; fission rates; reactivity measurements; expansion effect; and effective capture-to-fission ratio. (D.C.C.)

13535 (AI-AEC-12721, pp 185-6) FBR FUEL CLADDING AND STRUCTURAL MATERIALS. Keen, R. D. (Atomics International, Canoga Park, Calif.).

The performance of the high flux heater in the 2 in. Na test loop is described. (D.C.C.)

13536 (AI-AEC-12721, pp 261-73) FBR FUELS AND CLADDING. Ervin, G. Jr. (Atomics International, Canoga Park, Calif.).

Topics discussed include: preparation and properties of UC fuel; fabrication of UC and UC–W test specimens; and NRX reactor startup and operation. (D.C.C.)

13537 (AI-AEC-12721, pp 275-77) FBR FUELS AND CLADDING. Carroll, J. W. (Atomics International, Canoga Park, Calif.).

Optimum fabrication parameters for the melting and casting of PuC–UC fuel are evaluated. (D.C.C.)

13538 (BNWL–882) FFTF SODIUM SERVICE PRESSURE MEASUREMENT: STATE-OF-THE-ART REPORT. Crocker, T. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

The present level of technology of pressure instrumentation for liquid-metal test facilities and nuclear systems is described, and the characteristics of selected commercial models are outlined. The instruments are evaluated in relation to their potential for sodium service use in the Fast Flux Test Facility (FFTF). Transducers not considered are those with temperature limitations of less than 600°F and those designed for low pressure or vacuum service. 37 references are included. (auth)

13539 (BNWL–921) REACTOR PHYSICS QUARTERLY REPORT, JULY–SEPTEMBER 1968. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1968. Contract AT(45-1)-1830. 125p. Dep. CFSTI.

Topics discussed include: Reactor Theory and Code Development; Thermal Reactors; Fast Reactors; and Critical Mass Physics. (D.C.C.)

13540 (CONF-680832–5) HEAT TRANSFER PROBLEMS ASSOCIATED WITH THE LOFT EMERGENCY-CORE-COOLING PROGRAM. Ybarrondo, L. J.; Moore, K. V.; Evans, D. R.; Brockett, G. F.; Waage, J. M. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 13, 1968. 23p. Dep. CFSTI.

From 10th National Heat Transfer Conference, Philadelphia, Pa.

A discussion of the loss-of-coolant accident (LOCA) problem is presented along with a description of the related LOFT (Loss-of-Fluid-Test) program analysis development. Particular emphasis is placed on the progress, results, and problems associated with the development of the computer codes RELAPSE 3 and MOXY which describe the transient thermal response of the primary system and core, respectively. 4 references.

13541 (EUR–4082) THE USE OF THE SORA-REACTOR FOR NEUTRON PHYSICS EXPERIMENTS. Kley, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 14, 1968. 30p. (CONF-670501–17). Dep.

From International Conference on Research Reactor Utilization and Reactor Mathematics, Mexico City, Mex.

The optimalization of "Neutron Beam Experiments" at a pulsed reactor is described. In order to compare the merits of different instruments and techniques, general criteria are defined for the characterization of neutron beams. For overall economic reasons, the design layout of all the neutron beam facilities is made under the concept to use, if possible, in an experiment all the neutrons in a collimated beam and to detect all the scattered neutrons whenever the geometrical conditions allow it. Consequently, most facilities are designed for the use of a white neutron beam and so-called "quasimonochromatic neutrons." Neutron guide tubes are used as design element for almost all facilities. They play a primary role at pulsed reactors as "effective pulse shortener." 23 references. (auth)

13542 (EURFNR–550) STUDY OF THE DEPENDENCE OF THE REACTIVITY IN A 500 1 STEAM-COOLED FAST REACTOR ON THE STEAM DENSITY IN SNEAK-3A. Engelmann, P.; Raberain, A. M.; Wintzer, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK–776. 44p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A series of steam void and flood experiments have been performed in the uranium fueled SNEAK assemblies 3A-1 and 3A-2 in order to study the dependence on hydrogen concentration of the reactivity in the range $N_H = 0$ to $N_H = 3.6 \times 10^{21}$ cm^{-3}. A comparison of experimental data has been made with calculations using the 26-group SNEAK, SNEAK-PMB and ABN sets. All the calculations tend to underpredict the reactivity changes: both SNEAK-PMB and SNEAK set give reasonable values in the range $N_H = 0$ to $N_H = 1.8 \times 10^{21}$ cm^{-3} (working point), the maximum deviations being 5 and 15% respectively. The flood reactivity is underestimated with these sets by 20 and 25%. The ABN set, however, underpredicts both void and flood reactivities by 30 to 35%. 9 references. (auth)

13543 (GA–8882) A COMPILATION OF HOMOGENEOUS THERMAL SPECTRUM CRITICAL ASSEMBLIES. Traylor, R. C. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 20, 1968. Contract AT(04-3)-167. 55p. Dep. CFSTI.

A compilation of thermal homogeneous critical assemblies is presented. The list of assemblies is arranged according to moderator type and fissile isotopes, and by moderator to fissile isotope atom ratio. Critical mass, size, and reflector characteristics are also provided. 59 references are included. (D.C.C.)

13544 (ORNL-TM–2400) DESCRIPTION OF THE BSR 2-Mw REACTOR CONTROL AND INSTRUMENT SYSTEMS. Bates, A. E. G. (Oak Ridge National Lab., Tenn.). Oct. 1, 1968. Contract W-7405-eng-26. 37p. Dep. CFSTI.

During 1965 and 1966 modifications and additions were made to the Bulk Shielding Reactor (BSR) control system. These changes would permit the increase of the power rating from 1 MW intermittent to 2 MW continuous. The control was rearranged so that the reactor could be operated remotely from the ORR control room, in addition to the local control room. Other changes included were: adding a forced cooling system to the core, making provision for the installation and operation of as many as six shim-safety rods, and installing high-resolution television systems for surveillance of the BSR control panel and pool area during remote operation. (auth)

13545 (ORNL-TM-2458) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JULY–SEPTEMBER OF 1968. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Nov. 20, 1968. Contract W-7405-eng-26. 46p. Dep. CFSTI.

Operating experience, instrument and process maintenance, and experiment activities during July to September 1968 are described. (D.C.C.)

13546 HIGH PRESSURE REACTOR WATER LOOP. Zajic, Vladimir (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 1-10(Jan. 1969). (In Czech).

In 1966 a high pressure reactor water-loop with the atmosphere of CO_2 at 65 atm. was set into operation on the WWR-S reactor in the Institute of Nuclear Research for the investigation of pressurized water systems under radiation. It is intended to be applied to the research of corrosion of materials used in the heavy-water circuits of HWGCR power reactors being developed in Czechoslovakia, to the research of physical properties and functions of heavy-water circuits in a two-phase system (water–CO_2), to the investigation of radiolysis and purification of circulating water, to the development of necessary measuring and control devices, of dosimetric systems and to examination of decontamination methods efficiency. With respect to parameters of heavy-water circuits in the HWGCR types of power reactors, the equipment of this water-loop is provided to operate at temperatures up to 120°C. There is a hermetic circulating pump and tight servomotoric fittings. All circuits are made of 18Cr8Ni stainless-steel, packings of Al and of PTFE. Detailed data on the loop parameters are presented. (auth)

13547 SELF-LIMITING POWER EXCURSION TEST ON LIGHT-WATER REACTOR. Yamada, Shuji; Imai, Munemaru (Hitachi Ltd., Tokyo). Hitachi Hyoron, 50: No. 7, 66-70(July 1968). (In Japanese).

To prove the self-limiting power excursion of a light-water reactor, the pulse operation of Hitachi's HTR was carried out. In the experiment of reactivity insertion 1% $\Delta K/K$, period 29 ms, maximum power 38 MW, released energy 5.1 MWs and peak fuel temperature 625°C were reached. The calculation code for analysis of a reactivity accident, utilizing a two-point approximation dynamic characteristic model, was developed. Compared with the experiment of HTR, the code with experimental confirmations was established. The results of calculations and of the experiment agreed within 10%, proving the self-limiting power excursion of a light-water reactor. (NSA of Japan)

13548 NEUTRON REACTORS. Borst, L. B. (to The Dow Chemical Co.). Canadian Patent 796,899. Oct. 15, 1968.

A subcritical neutron amplifier is used having a controllable stimulating neutron source and associated with it in cascade, several amplifier stages. Each stage includes an input region containing neutron moderator material in which epithermal neutrons from the source are moderated to thermal energy levels. There is a fuel region containing fissionable material in mass concentration with geometry adapted to augment the neutron flow by a steady state subcritical reaction. Between successive stages a neutron barrier is placed which is opaque to thermal neutrons but transparent to epithermal neutrons. Thus, an amplified output of epithermal neutrons is subcritically produced. The amplifier has a Pb of Bi barrier in the moderator zone which inelastically scatters epithermal neutrons thereby inhibiting the backward flow of neutrons from a given stage to the preceding stage of the amplifier. (F.S.A.)

13549 STUDIES OF THE CRITICALITY OF 20 PERCENT ENRICHED URANIUM FAST CRITICAL ASSEMBLIES (FCA-I). Hirota, Jitsuya; Nomoto, Shoji; Hirakawa, Naohiro; Nakano, Masafumi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 6: 35-42(Jan. 1969).

A series of critical experiments and analyses have been made on cylindrical assemblies fueled with 20% enriched uranium metal in the JAERI fast critical facility. The first assembly contains in the core 10.8% of stainless steel and 6.5% of void by volume, and is provided with a natural uranium blanket 30 cm thick. Based on a number of correction experiments, the critical mass of the assembly was determined to be 94.9 ± 0.3 kg of ^{235}U. With a reduced blanket thickness of 10 cm, the critical mass was found to increase by 16.4%. When one quarter of the enriched uranium metal was substituted by graphite, the critical mass increased by 36.6%. Comparison of these results with theoretical calculations indicated that the criticality of the assemblies can be well estimated by means of the S_n approximation with ANL-635 set. (auth)

13550 NEARLY COMPLETE FLATTENING OF POWER RELEASE ALONG RADIUS OF HETEROGENEOUS REACTOR. Bat, G. A.; Gulimov, V. N.; Obukhov, V. K. At. Energ. (USSR), 26: 7-10(Jan. 1969). (In Russian).

Experimental and design data are reported of the investigation of multi-region water-reflected U-water critical assemblies with radial irregularity factors of $k_r < 1.10$. The number of regions differing in the lattice spacing and the ^{235}U concentration in fuel elements is as great as 9. A brief description is given of a critical assembly bench methods for measurements and design scheme used. A comparison is made of experimental and design data; the results are discussed as applied to reactors with direct thermoionic conversion of fission energy into electrical one. 5 references. (auth)

13551 MAJOR HEALTH PHYSICS EXPERIENCES DURING 15 YEARS OF REACTOR TESTING. Horan, J. R. (Atomic Energy Commission, Idaho Falls, Idaho). pp 541-6 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The case histories of the major incidents involving the uncontrolled release of radioactive materials and radiation exposure to personnel are reviewed. The most serious incidents in the 15-year operating history of the National Reactor Testing Station are presented in an ascending order of seriousness using the following categories: (1) Property Damage, (2) In-plant Contamination, (3) Environmental Contamination, (4) Inhalation Exposure, (5) External Total Body Exposure, (6) Radiation Injury, and (7) Maximum Credible Accident. (auth)

Rocket and Space Reactors

Refer also to abstracts 11656 and 11700.

13552 (AERE-R-5773(Vol.3), pp 858-900) THE DESIGN AND PERFORMANCE OF AN OPEN-WELL SHIELD FOR HIGH-POWER PROPULSION REACTOR TESTING. Graves, Glen A. (Los Alamos Scientific Lab., N. Mex.).

The 1500 MW Phoebus 1B reactor and its 81 in. dia open-well shield constitute a unique combination of a high-power reactor source coaxial with a respectably attenuating bulk shield system possessing a single large end opening permitting free radiation leakage. The kinds of reactors tested in the nuclear propulsion program are mentioned. The basic Phoebus 1B reactor type with enough detail to permit valid external radiation environment calculations is described. The final shield is carefully described. Measurements relating to the shield system's performance are given. These include its reactivity effects, its thermal performance (including that of its borated-water coolant system), its lateral attenuation, and its effect on neutron fluxes in the area. (17 references) (auth)

13553 (ORNL-TM-2423) COMPARISON OF MONTE CARLO CALCULATIONS WITH MEASUREMENTS OF FAST-NEUTRON DOSE TRANSMITTED FROM A BEAM SOURCE THROUGH A SNAP-2 LiH SHIELD. Cain, V. R.; Franz, K. D. (Oak Ridge National Lab., Tenn.). Dec. 18, 1968. Contract W-7405-eng-26. 8p. Dep. CFSTI.

Measurements and calculations were made of fast-neutron dose rates transmitted through a LiH SNAP shield surrounded by a collar shield of iron and oil. This was done in order to evaluate the Monte Carlo techniques used to design the experimental configurations for SNAP shielding experiments at the Tower Shielding Facility. Comparisons were made for a number of typical configurations and the calculated and measured fast-neutron dose rates for neutrons leaving both the LiH shield and the collar shield are in excellent agreement. This establishes the validity of this technique for analyzing future experiments. 10 references. (auth)

13554 COMPARISON OF FISSION PRODUCT RELEASES FROM THE DESTRUCTIVE TESTS OF TWO SNAP 10A/2 REACTORS. Cordes, O. L. (Phillips Petroleum Co., Idaho Falls, Idaho). Contract AT(10-1)-205. pp 571-87 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

In separate experiments two modified SNAP 10A/2 flight system reactors containing fuel made of a cement of U-ZrH were intentionally destroyed. One of these reactors was tested while immersed in water and the other was tested in air to determine the consequence of an uncontrolled self-limiting excursion in each of these environments. The fission product release information obtained from these experiments is compared and the fission product retention effect of the water environment is evaluated. The major conclusions reached regarding the retention effect of the water environment are that: (1) The water cooling effect on the hot fuel, which limited the destruction of the fuel and caused the fission products to remain trapped in the fuel matrix, is an important mechanism in suppressing the release of fission products. (2) The release fraction of noble gas fission products is greatly reduced by a water environment. Only 4% of the total noble gas fission products were released from the water-immersion test. (3) Halogen and "solid" fission products from an underwater destruction excursion are completely retained, provided the water environment exists following the excursion. (auth)

13555 RADIOLOGICAL ASPECTS OF A REACTOR DESTRUCTIVE TEST. Bunch, D. F.; Gammill, W. P. (Atomic Energy Commission, Idaho Falls, Idaho). pp 589-600 of Radiation Protection. Part 1. Snyder, W. S.; Abee, H. H.; Burton, L. K.; Maushart, R.; Benco, A.; Duhamel, F.; Wheatley, B. M. (eds.). New York, Pergamon Press Inc., 1968.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy. See CONF-660920-(Vol.1).

The radiological considerations connected with planning and conducting reactor destructive tests at the National Reactor Testing Station in Idaho are described. In one test a modified SNAP-2/10A reactor was intentionally disassembled as a result of a nuclear excursion designed to simulate the "maximum accident" for this system. The primary radiological objectives were to determine the magnitude of the fission product release and to assess the radiation exposures resulting from the test. Information on planning prior to the tests and a summary of the radiation exposures resulting from the releases are presented, with special emphasis given to the SNAPTRAN-2 Destructive Test. It is shown that, by using a properly designed environmental sampling system and the statistical approach of atmospheric dispersion, one can quickly and accurately estimate the magnitude of a release. An equation is shown which is amenable to hand or computer solution and will allow estimates of the fractionation of the fission products. Many of the considerations are applicable to any test involving the release to the atmosphere of significant quantities of fission products. (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 13364 and 13365.

13556 (ORNL-4202) THE UNCLAD-METAL BREEDER REACTOR (UMBR) FOR DESALTING OR POWER. Hammond,

R. P.; Burwell, C. C.; Carlsmith, R. S.; Delene, J. G.; Fuller, L. C.; Goldman, A. E.; Lloyd, D. B.; Roberts, J. T.; Savolainen, J. E.; Wichner, R. P. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 141p. Dep. CFSTI.

Reactor concept studies are being conducted under the Nuclear Desalination Program at ORNL to investigate the possibilities of producing low-cost low-temperature heat suitable for seawater distillation. The findings of preliminary investigations of Na-cooled fast breeder reactors fueled with unclad-metal are presented. Three fuel materials are considered: Th-based Th–U binary alloys; Th-based Pu–Th–U ternary alloys; and U-based alloys. Together with the two unclad-metal blanket materials (Th and U) used singly or jointly, a number of reactor core combinations is possible. Use of unclad metals as core and blanket materials appears to be technically feasible, based on the incomplete available data. Good breeding gains and doubling times were calculated for all systems considered because of the absence of cladding and other diluents. The characteristics of two reactors fueled with the Th-based Pu–Th–U ternary alloy combined with U blanket material are presented. The less desirable low-temperature all-U-based fuel system and the nearer term high-temperature all-Th-based fuel system are discussed briefly. The two reactors considered are one designed primarily for low-temperature steam production for desalting and one designed primarily for power production. (auth)

13557 (ORNL-TM-2046) FUEL CYCLE ECONOMIC ANALYSIS OF OXIDE FUELED POWER AND PROCESS HEAT PWR'S FOR SEAWATER DESALINATION. Rabe, E. P. Jr.; Jones, J. E. Jr.; Robin, T. T. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 62p. Dep. CFSTI.

Economic studies were conducted to determine minimum equilibrium fuel cycle costs for two oxide fueled PWR concepts. Each reactor is to be used to generate steam for a single-purpose desalination plant. The two reactor concepts studied were a commercial "product line" power reactor and a lower temperature process heat reactor. Fuel cycle costs were based on economic ground rules believed to be representative for reactors going "on-line" in the 1960's. The study indicated that, for a publicly owned reactor utilizing a privately owned 75,000 MW(t) capacity fabrication plant, equilibrium fuel cycle costs of 0.348 mill/kWhr(t) and 0.324 mill/kWhr(t) could be expected from commercial power and process heat reactors, respectively. These costs are based on an ore cost of \$8.00/lb U_3O_8, a separative work charge of \$26/kg U and a tails of 0.20 wt % ^{235}U. For a privately owned reactor using the same fabrication-reprocessing complex, corresponding fuel cycle costs are 0.385 and 0.367 mill/kWhr(t). If the reactor is publicly owned and the complex is publicly owned with a 15,000 MW(t) industry capacity, equilibrium fuel cycle costs are 0.402 and 0.381 mill/kWhr(t), respectively. 17 references. (auth)

13558 PRODUCTION OF FRESH WATER AND ENERGY IN A HALF CENTURY. Escande. RUM, Rev. Universelle Mines, 111: 193-7(July 1968). (In French).

New sources of nuclear fuels and constantly improving technology support the validity of nuclear plants as the solution to energy and fresh water problems of the future. Establishment of nuclear plants and the planning of others in the United States comprise a source of 50×10^6 kW(e); acceptance by the public has been based on low cost, excellent safety records, and minimal air pollution. The trend in construction of central nuclear stations will be towards combinations of plants of 10×10^6 kW(e), where each plant will produce 1 to 2×10^6 kW(e). A combination plant in California, producing 4000 m^3 water per day at reasonable cost, is viewed as a pilot unit leading to construction of a triple complex producing 6×10^5 m^3/day; the California plant will also produce 1.8×10^6 kW(e) at competitive prices. A mixed plant in the Soviet Union will drop prices to the point where desalinated water can be used not only for urban consumption but for irrigation as well. Such plants must be located at the seashore, providing tourist attractions for these areas, and improved control in problems of air and marine pollution. (BBB)

13559 15th SECTIONAL MEETING OF THE WORLD POWER CONFERENCE, TRANSACTIONS, TOKYO, 16–20 OCTOBER 1966. VOLUME II. Tokyo, Japanese National Committee, World Power Conference, 1966. 415p. (In English and French). (CONF-661066–(Vol.2)).

Included are 19 papers grouped under the general topic of coordination of the energy industries. Subsections include: National Policy, Industries Based on Coal, Industries Based on Petroleum, and Water Desalination. Separate abstracts were prepared for each of 5 papers on the application of nuclear energy for water desalination. (H.D.R.)

For abstracts of individual papers see: 13560–13564.

13560 TECHNICAL AND ECONOMIC PROBLEMS OF LARGE DUAL-PURPOSE PLANTS FOR POWER GENERATION AND SEA WATER DESALINATION. Aschner, F. S.; Yiftah, Sh.; Glueckstern, P. (Technion–Israel Inst. of Tech., Haifa). pp 674-87 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. II. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.2).

Since 1959, the Technion, Israel Institute of Technology, has investigated the technical and economic problems of the use of nuclear energy for generating steam for sea water flash distillation plants. In February 1964, a research contract on this subject was concluded with the International Atomic Energy Agency. The methods and the results of two years of research under this contract are reported. In dual-purpose plants, which were investigated for the range of 50 to 300 MW(e) net output, nuclear reactors are more economical than conventional steam generation at net outputs above 100 to 125 MW(e). In June 1964 a U.S.–Israel agreement was signed to determine the feasibility of a large desalting plant to be built at the Mediterranean Sea coast of Israel. The report on this study, which was concluded in January 1966, recommends the installation of a nuclear dual-purpose plant for generation of 200 MW salable electricity and desalination of 100 million gallons per day (approx. 120 millions m^3 per year) of sea water for commissioning in 1972. The construction cost of such a plant will be 190 million dollars. The cost per cubic meter of desalinated water at the plant boundary will be 7.6, 11.5, and 17.7 cents at fixed charges of 5, 7, and 10% respectively. (auth)

13561 THE ECONOMICS AND SYSTEM INTEGRATION OF DUAL-PURPOSE POWER AND WATER PLANTS. Baron, S. pp 768-85 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. II. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.2).

The thermodynamics of dual-purpose plants and how the economics is applied to obtain low energy costs for desalination are analyzed. However, the economic gains of dual purpose have certain cost limitations and penalties that must be appraised in order to fully evaluate its advantage on the total integrated power and water system. To appreciate the significance of all the integration factors, correlations of energy costs, water costs, conveyance and storage costs are presented. The effect of all these costs, including nuclear energy, upon the total delivered water costs is shown in a typical example of a system integrating desalinated water with existing water supplies. (auth)

13562 NUCLEAR ENERGY AND SEA WATER DESALINATION. Gaussens, J. (CEA, Paris). pp 798-813 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. II. Tokyo, Japanese National Committee, World Power Conference, 1966. (In French).

See CONF-661066–(Vol.2).

To meet a stated demand in optimum conditions, the desalted water production cost depends on the choice of certain parameters which concern either the desalting plant or the supply of power. The sensitivity of these choices to the pattern and size of the water demand, its development with time, and to the possibilities of selling the surplus of electricity produced are discussed. With the help of a suitable methodology, the technical and economic thresholds, i.e., the plant sizes and characteristics beyond which the use of nuclear energy becomes more economical than conventional power sources, are defined. Thus are determined the conditions which must be met, from the standpoint both of desalting or power generation techniques and of water demand, to justify the use of nuclear energy. (auth)

13563 USE OF NUCLEAR ENERGY FOR WATER DESALINATION. Brice, D.; Khan, M. A.; Krymm, R. (International Atomic Energy Agency, Vienna). pp 844-58 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. II. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.2).

The role which nuclear energy may play in the field of desalination is examined. Desalting techniques, developments in reactors, and desalted water costs are reviewed. Examples are presented to indicate the potential costs of water desalination. (H.D.R.)

13564 DESALINATION OF WATER DEVELOPMENT IN THE UNITED KINGDOM. Kronberger, H. pp 872-85 of 15th Sectional Meeting of the World Power Conference, Transactions, Tokyo, 16–20 October 1966. Vol. II. Tokyo, Japanese National Committee, World Power Conference, 1966.

See CONF-661066–(Vol.2).

The U.K.A.E.A. in conjunction with industry has embarked on a 3 year program to exploit the development potential of distillation; to study the combination of nuclear power and desalination plants; and to investigate alternative methods of desalination. A design study was carried out for a plant producing 45,500 m^3 (10 million Imperial Gallons) per day. A number of these units are being considered in combination with an Advanced Gas Cooled Reactor or an S.G.H.W. to form dual purpose plants for the production of electricity and water. Performance parameters and costs are given for typical schemes with outputs of 136,000, 272,000, and 364,000 m^3/d. (30, 60, and 80 m.g.d.). The main items of the experimental program on distillation are the study of plant geometry, corrosion and scale formation. Of the alternative methods, electrodialysis and reverse osmosis were selected for further study. An electrodialysis pilot unit of improved design is under construction. The experimental work on reverse osmosis is concentrated on studying the detailed mechanism of water transport through membranes, the development of improved membranes and engineering details of support structures. (auth)

Marine and Portable Power Reactors

13565 (AERE-R-5773(Vol.4), pp 989-98) COMPARISON OF CALCULATED VALUES WITH ACTUAL GAMMA DOSES PENETRATING THROUGH SHIP STRUCTURES. Nakata, Masaya; Kataoka, Iwao; Kanai, Yasuji (Ship Research Inst., Tokyo (Japan)).

Gamma dose rate data on the training ship "Shintoku-maru" of about 3500 gross tons were obtained with ion-chamber type dosimeters, by placing a 0.1 mCi ^{60}Co γ source on the second deck corridor and in a drying room on the lower flat. Calculations were performed on the NEAC 2206 computer with the codes "MARINE-I" and "MARINE-II" which assume an inverse square law of attenuation with distance and Peebles' build up factors. All observed data fell below the expected levels, but the comparison seems to show there are superimposed effects of a systematic deviation together with some random variation. The results suggest that a correction factor is needed in such complicated radiation shields and some improvement of the build-up factor treatment is required. (4 references) (auth)

13566 (AERE-R-5773(Vol.5), pp 1346-72) SHIELDING STUDIES FOR THE FIRST NUCLEAR SHIP OF JAPAN. Nishibori, E. (Japan Nuclear Ship Development Agency, Tokyo); Furuta, Y. (Japan Atomic Energy Research Inst., [Tokyo]); Fuse, T. (Ship Research Inst., Tokyo (Japan)).

Extensive shielding studies for the first nuclear ship of Japan were performed in order to confirm the validity of basic design methods and to obtain useful experimental data for complicated problems in shielding. In the primary shield studies, the neutron and γ-ray attenuations were measured with mockups placed in the pool of JRR-4, and the results were compared with calculations using several computer codes. Valuable information was obtained for the radiation distribution in the reactor core radial direction and oblique-upward direction as well as for the shielding effects of control rod structure. In the secondary shield studies, mockups of the shields of some typical configurations were placed in the dry test facility of JRR-4. γ-ray dose albedos and the backscattered neutron spectrum were measured, and the behavior of γ rays incident on shields having a duct, a hole or a slit was studied. (6 references) (auth)

13567 (ORNL-TM-2349) INSPECTION OF EUROPIUM-BEARING CONTROL RODS FROM THE ARMY SM-1A STATIONARY MEDIUM POWER REACTOR. Richt, A. E.; Haynes, V. O. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 39p. Dep. CFSTI.

Four neutron-absorber elements which had experienced 14.1 or 26.7 MWyr of service in the SM-1A Stationary Medium Power Reactor were examined nondestructively to determine if they were structurally and dimensionally suitable for additional use. These elements are composed of four composite absorber plates welded together to form a square, hollow tube. The stainless steel-clad absorber plates contain a dispersion of 37 wt % Eu_2O_3 in stainless steel as the neutron-absorbing material. Results of this inspection indicated that all four absorber elements are in excellent physical condition. Since the absorber elements appear to be dimensionally and structurally suitable for additional service, they have been placed in temporary storage until arrangements for additional testing are complete. (auth)

13568 NUCLEAR POWER OPERATIONS, DEEP FREEZE 67-68. Fort, Robert E.; Evans, Tommy R. (Naval Nuclear Power Unit, Fort Belvoir, Va.). Antarctic J. U. S., 3: 146-8 (July-Aug. 1968).

Operation of the PM-3A nuclear power plant at McMurdo Station during the 1967 winter and the Deep Freeze 68 summer season is reviewed. (BBB)

13569 ON THE PROBLEM OF PORT CALL BY THE U. S. NUCLEAR SUBMARINES. Atomu, 13: No. 6, 28-40(July 1968). (In Japanese).

For the port call by U. S. nuclear submarines, the radiation monitoring system has been a major problem due to suspected radioactive contamination. The recent port call by the Swordfish has emphasized the necessity for the monitoring system. A collection of short articles concerning this problem is presented. Topics discussed include: the course of radioactivity investigations associated with the call to Sasebo Port by the Swordfish; measures taken concerning the port call; an interim report by the group on the radioactivity investigations; a report of the experts discussion meeting; radioactivity investigations at Sasebo Port; investigations considered for the port call by other nuclear warships; and press releases in connection with the Swordfish's port call. (NSA of Japan)

Reactor Theory

Refer also to abstracts 13180, 13185, 13187, 13190, and 13539.

13570 (CONF-680832-4) CORE COOLING IN A LOSS OF COOLANT ACCIDENT. PART I. HEAT TRANSFER IN EARLY STAGE OF LOC. PART II. HEAT TRANSFER IN CORE MELTDOWN. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). [1968]. 18p.

From 10th National Heat Transfer Conference, Philadelphia, Pa.

Heat transfer during a coolant loss accident is discussed; pressure blowdown characteristics and transient DNB heat flux are shown. An empirical formulation for steady state transition boiling is given; the transition boiling heat transfer coefficient is shown graphically. Heat transfer mechanisms in a core meltdown are discussed. 10 references. (M.L.S.)

13571 (EIR-140) KINF, A PROGRAM FOR TWO-DIMENSIONAL REACTOR CELL CALCULATIONS BY THE MONTE CARLO METHOD. Marti, J. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug. 1968. 52p. (In German). Dep.

The physical model for the KINF program for calculation of core neutronics characteristics is described. Working equations for the fission spectrum, energy dependent cross sections, elastic and inelastic scattering, and resonances are given; scattering and fission neutron effects are considered. The Monte Carlo techniques used in the KINF program are discussed; calculated results are compared with measurements. An example is included. 29 references. (M.L.S.)

13572 (EUR-4087) THE INVESTIGATION OF FAST PULSED ASSEMBLIES USING THE MONTE CARLO METHOD. Kschwendt, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Sept. 17, 1968. 116p. (In German). Dep.

Thesis. Submitted to Graz Univ., Austria.

The structure of the time dependent solution of the neutron transport equation is studied in small pulsed assemblies using the Monte Carlo method, which is specially suited for the description of short time behavior. A large computer code was developed which treats all nuclear reactions of interest in slabs, spheres and cylinders and all types of spectra. Stationary fast leakage spectra show good agreement with experiments and Sn-calculations and a similar situation exists for the mean generation times. In one group cases, the time dependent decay of the neutron population is exponential but space dependent. For Pb and Cu blocks, the agreement between calculated and measured values is satisfactory, but a fundamental mode cannot appear. In the case of multiplying media, a fundamental mode can be observed as soon as the multiplication factor exceeds 0.9. 26 references. (auth)

13573 (KFK-786) REACTOR DYNAMICS TOPICS RECENTLY INVESTIGATED AT KARLSRUHE. Borgwaldt, H.; Kuesters, H.; Kussmaul, G.; Meister, H.; Thurnay, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). June 1968. 24p. (EUR-3958; CONF-680414-3). Dep.

From Conference on Industrial Needs and Academic Research in Reactor Kinetics, Upton, N. Y.

In review of recent work at Karlsruhe results from three fields of investigations are reported: the theory of neutron noise in a reactor with prompt and delayed neutrons for an external control loop; the kinetics equations for a step change in reactivity for two symmetrically coupled cores with equal parameters in terms of familiar point-reactor expressions; and the analysis of fast reactor dynamics with digital and analog computing methods, especially for steam-cooled systems including the primary circuit. In the fast reactor dynamics analysis several coolant channels can be treated in parallel with appropriate equations of state for the coolant. In large power excursions with core disassembly the autocatalytic effect in two-zoned cylindrical reactors is discussed in detail, showing the inadequacy of the normally used theoretical model. 22 references. (auth)

13574 (ORNL-tr-2084) CONTROL ROD REACTIVITY MEASUREMENTS WITH THE "ROD-DROP" METHOD. Farinelli, U.; Musco, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated for Oak Ridge National Lab., Tenn., from report RT/FI-(68)24. 20p. Dep. CFSTI.

The use of the rod-drop method for determining the effective multiplication factor of a reactor when this factor is below unity is described. Advantages and disadvantages of the method are described. An analytical model is presented which is similar to reality and makes corrections for limitations in the rod-drop method. 15 references are included. (D.C.C.)

13575 (RFP-1186) COLLISION PROBABILITY CALCULATIONS OF MULTIPLICATION FACTORS FOR LATTICES. Hunt, Douglas C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 10, 1969. Contract AT(29-1)-1106. 11p. Dep. CFSTI.

A multigroup version of the method of successive generations was used to determine the multiplication factors of unmoderated and unreflected periodic lattices of identical fissile components. The lattice components must be one dimensional (i.e., spheres, infinitely long cylinders, or infinite slabs). Lattices of nearly one-dimensional components (cubes or long cylinders) may, however, be approximately treated. The lattice components may be arranged in a linear, planar, or cuboidal manner; the permissible component arrangements being limited by the lattice component geometry. The computation traces successive neutron collisions in the lattice, starting from a uniform neutron-source density distribution in each lattice component. The initial source-density energy distribution is specified in a 16-group format which is obtained from S_4 transport equation solutions. (auth)

13576 (RPI-328-142, pp 132-51) REACTOR PHYSICS: THEORETICAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The problem of re-entrant hole effects on time-of-flight experiments was studied; good correlation between theoretical predictions and experimental results for thermal spectrum experiments was obtained. Single-region and two-region fast spectrum experiments were also analyzed. As an outgrowth of this work, a systematic comparison was made of the commonly used definitions of average scattering angles; it was concluded that significantly different values of the angle can be obtained. Analytic and numerical treatments of the time-dependent flux in pulsed fast systems were studied. Analytic expressions were obtained for fast reactor flux and importance spectra in terms of simple cross-section ratio correlations. The application of Green's function modes to the analysis of space-time kinetics showed that, at least in a series of test cases, spatially discontinuous Green's function modes are quite successful in predicting power shifts. The discontinuous variational method approach to space-energy problems was studied, with emphasis on the formulation of time-discontinuous initial-value problems. It was shown that, by using asymmetric discontinuities, the need for staggered discontinuities may be eliminated. It was also shown that use of asymmetric discontinuities is consistent with the forward bias of the time-like variable in an initial-value problem. (D.C.W.)

13577 TWO-GROUP REACTOR NOISE ANALYSIS BY LANGEVIN'S TECHNIQUE. Nieto, J. M. (Univ. of Michigan, Ann Arbor); Akhtar, P.; Ackermann, N. J. Jr. J. Nucl. Energy, 22: 675-85 (Nov. 1968).

Langevin's technique is applied to the two energy group space independent reactor model. Detection statistics and fluctuations in production and decay rate of delayed neutron precursors are taken into account. Expressions for the auto- and cross-correlation functions of the fluctuating sources associated with various random processes such as fission, capture, and scattering are obtained and used in finding the auto- and cross-power spectral densities of the detection rates in fast and slow groups. Numerical estimates for various break frequencies for a representative set of parameters are found. (auth)

13578 SPACE AND ENERGY CONSIDERATIONS OF THE FUCHS' MODEL. Ghatak, A. K. (Indian Inst. of Tech., New Delhi). J. Nucl. Energy, 22: 699-703(Nov. 1968).

The Fuchs' model equation is derived from a general neutron balance equation, and precise definitions of the temperature coefficient and prompt neutron lifetime are obtained. These definitions are shown to be in agreement with the corresponding static definitions obtained from perturbation theory. (UK)

13579 NEW APPROXIMATE ANALYSIS OF NONLINEAR SPACE-DEPENDENT REACTOR DYNAMICS DUE TO REACTIVITY ACCIDENTS. Wakabayashi, Jiro; Yoshikawa, Hidekazu (Kyoto Univ.). J. Nucl. Sci. Technol. (Japan), 6: 20-7(Jan. 1969).

The nonlinear space-dependent reactor dynamics related to reactivity accidents have been studied analytically by means of a modified Helmholtz modal expansion method. In this method the neutron fluxes and delayed neutron precursors are expanded in terms of steady state or asymptotic shapes and of the shapes of higher eigenfuctions of the Helmholtz equation satisfying the boundary conditions that the values of eigenfunctions at the extrapolated boundary of reactor are zero. The expansion coefficients are time-dependent, and are obtained by solving simultaneous nonlinear differential equations. A code, SPEX-1, was developed for the computations with which a sample calculation was performed on a problem concerning the self-shutdown behavior due to Doppler feedback in a power excursion. The merits of the modified Helmholtz modal expansion method are: improved convergence of the solution as compared with the conventional modal expansion procedure; easy comparison with the one-point kinetic model; and simplicity of the procedure of calculations related to power excursion analysis. (auth)

13580 STOCHASTIC OPERATOR METHOD OF CALCULATING THE TIME INTERVAL DISTRIBUTIONS IN NEUTRON DETECTION. Kurihara, Kunitoshi; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 28-34(Jan. 1969).

An operator method has been applied to formulate probability distribution functions of neutron counts in a reactor. Assuming all statistical events occurring in the reactor to be Markovian, an operator representation of the no count probability for a given time interval is given. The basic equation for the probability is derived from the Kolmogorov–Chapman equation, and the formal solution obtained thereof. Approximate expressions are also given for absorption and fission detectors. The effects of moments of order higher than the second are evaluated numerically. Further development of the operator calculus has yielded relations connecting the waiting time distribution and the interval distribution with the no count probability. 14 references. (auth)

Experimental Applications

Refer also to abstracts 13183 and 13184.

13581 NOTE ON THE HETEROGENEITY EFFECT OF SODIUM SCATTERING RESONANCE ON NEUTRON SPECTRUM. Tone, Tatsuzo (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 6: 43-4(Jan. 1969).

A method is described which uses the collision probability technique to determine the effects of sodium resonance in a lattice of cylindrical fuel pins and sodium. Typical neutron spectra and collision densities are shown. Fuel characteristics are tabulated. (M.L.S.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 11665, 11688, 11692, 11734, 11918, 11[illegible]. 12260, 12396, 12400, 12401, 12441, 12444, and 13409.

13582 (AI-AEC-12721, pp 211-24) FBR FUEL DEVELOPMENT, FUEL CLADDING, AND STRUCTURAL MATERIALS. McKisson, R. L.; Hopenfeld, J. (Atomics International, Canoga Park, Calif.).

A model to describe the mass transfer process in cladding materials in a Na environment and with a temperature gradient is analyzed. The development of a high heat flux heater capable of operating for a minimum of 1000 hours at a minimum heat flux of 1×10^6 BTU/hr ft^2 is described. (D.C.C.)

13583 (ANL-7203(Add.)) ADDENDUM TO THE REPORT ON HIGH CONVERSION CRITICAL EXPERIMENTS. Plumlee, K. E. (Argonne National Lab., Ill.). Aug. 1968. Contract W-31-109-eng-38. 10p. Dep. CFSTI.

Revised results for the conversion-ratio measurements reported in ANL-7203 are presented. All the results have been revised downward by net relative reductions of ~4 to 15%. The revision is necessary because of the application of a more appropriate method of data analysis than originally used. The improved analysis adjusts accurately for the epicadmium flux component in graphite thermal columns, which affected the reference irradiations used for normalization of these measurements. The revised results for initial ratios range from 0.44 ± 0.01 to 1.25 ± 0.04 for H : ^{235}U atom ratios of 4.16 down to 0.50 (which is a subcritical composition), using 3.04 w/o enrichment UO_2 fuel and H_2O moderator and reflector. The UO_2 pellet diameter was 0.935 cm, and an average of 853.3 g was contained as a 121.9-cm-length column in each fuel element. The cladding was 1.06-cm-OD stainless steel with 0.05-cm wall thickness. 4 references. (auth)

13584 (CONF-680504-2) MANUFACTURE OF NUCLEAR FUEL RODS BY VIBROCOMPACTION OF UNIFORM SIZE CERAMIC POWDERS. van Asbroeck, Ph. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Wieczorkowski, M. (Institute of Nuclear Research, Swierk (Poland)). [1967]. 22p. (In French). Dep.

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany.

In the vibrocompacting method of nuclear fuel fabrication loose powder is filled into the fuel can and then compacted by vibration. In order to reduce the cost of the vibrocompacting, it is suggested to use powders of one particle size only and apply them in the form of small cylindrical sintered pellets. The properties of the materials as well as the processes of filling and vibrating are described. It is shown that cylindrical pellets of the right size are easily compacted by vibration, resulting in a rearrangement and breakdown of particles leading to a density of 85% T.D. (auth)

13585 (WCAP-3269-22) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, April 1–June 30, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3269. 16p. Dep. CFSTI.

The effects of heat transfer and isothermal conditions on the corrosion and hydriding of Zircaloy 4 tubing are analyzed. Results are presented. (D.C.C.)

13586 STUDIES ON THE URANIUM-CARBIDE DISPERSED SILICON-CARBIDE NUCLEAR FUEL. 2. Nishikawa Kazuo; Manabe, Genroku (Furukawa Electric Co., Ltd., Tokyo). FAPIG (Tokyo), No. 49, 48-51(June 1968). (In Japanese).

Concerning UC dispersed SiC nuclear fuel, experimental study was carried out on the production of spherical UC particles coated with SiC. The results obtained are described. (NSA of Japan)

13587 SUBSONIC FLUID FLOW LOSSES IN COMPLEX PASSAGES AND DUCTS. Symposium Held at London, Oct. 4–5, 1967. Proc. Inst. Mech. Eng. (London), 182: 1-163(1967–68). (CONF-671077).

Separate abstracts were prepared for 6 of the papers. The 10 other papers included relate to fluid flow losses in heat exchangers, turbines, electrical machine cooling systems, and diesel engines. A record of the opening address and discussion of the papers is included. (UK)

For abstracts of individual papers see: 13487–13492.

13588 EXPERIMENTAL INVESTIGATION OF A FILM HEAT-TRANSFER COEFFICIENT IN THE FUEL ELEMENT SPACERS AREA. Vlcek, J.; Weber, P. (SKODA Works, Plzen, Czech.). Jad. Energ., 14: 419-25(Dec. 1968). (In Czech).

Results of a heat-transfer experiment in annuli with different spacers are reported. A review of this problem, derivation of basic equations, description of experimental devices, and some of results are presented. The experimental data utilization and extension for both power design of nuclear reactor fuel elements and hot spot factors analyses are discussed. (auth)

13589 SWITCH OPERATING MEANS FOR USE IN THE CONTROL OF NUCLEAR REACTORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,141,200. Jan. 29, 1969. Priority date July 20, 1965, Germany.

REACTOR CONTROL ELEMENTS—drive switching system for, description of spring-retarding bottom-end electric-type

SWITCHES—control rod drive, description of spring-retarding bottom-end electric-type (D.L.C.)

13590 SEALING SYSTEM FOR THE ROTARY PLUG OF A NUCLEAR REACTOR. Gallo, Sabino (to Commissariat a l'Energie Atomique). British Patent 1,141,434. Jan. 29, 1969. Priority date Nov. 17, 1966, France.

REACTORS, LIQUID METAL-COOLED—seals for, description of lipped- and inflatable-type rotary plug

SEALS AND GLANDS—liquid metal-cooled reactor lipped- and inflatable-type rotary plug, description of (D.L.C.)

13591 NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,141,564. Jan. 29, 1969. Priority date Oct. 19, 1965, Belgium.

REACTOR CONTROL ELEMENTS—drives for rod-type, description of drop-type piston-actuated hydraulic damped-action coolant-flow-regulated (D.L.C.)

13592 DEVICE FOR VERIFYING THE OPERATION OF AN ELECTROMAGNET. (to Groupement Atomique Alsacienne Atlantique (GAAA)). British Patent 1,142,567. Feb. 12, 1969. Priority date July 29, 1965, France.

MAGNETS—operation in reactor loading machines of electro-, device for remotely verifying

REACTOR LOADING MACHINES—electromagnets for, device for remotely verifying operation of (J.M.J.)

GENERAL

13593 (AAEC/E-195) SOME ITERATIVE METHODS FOR SOLVING THE MATRIX EQUATION Ax = b. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1968. 14p. Dep.

The salient features of a number of iterative methods for solving the matrix equation Ax = b are reviewed and includes a brief description of the calling sequences to FORTRAN subroutines written for the IBM 360/50 with an assessment of the computational efficiency of the different methods for low order full matrices is included. Some attention is given to the question of acceleration and the necessity for double precision arithmetic. (auth)

13594 (ANL-7315) THERMODYNAMIC PROPERTIES OF SOME CHALCOGEN FLUORIDES. O'Hare, P. A. G. (Argonne National Lab., Ill.). July 1968. Contract W-31-109-eng-38. 95p. Dep. CFSTI.

Physical and thermodynamic data are presented for 24 gaseous fluorides of the oxygen-group elements. Data are also included for the liquid and solid states where enthalpies of vaporization and fusion are available. The thermodynamic functions $-(G^0 - H_0^0)/T$, $(H^0 - H_0^0)/T$, S^0, C_p^0, $H^0 - H_{298}^0$, ΔHf, ΔGf, and log Kf are tabulated from 0 to 2000°K. (auth)

13595 (BMI-171-004) BIOENVIRONMENTAL AND RADIOLOGICAL-SAFETY FEASIBILITY STUDY ATLANTIC-PACIFIC INTEROCEANIC CANAL: DARIEN ETHNOBOTANICAL DICTIONARY. Duke, James A. (Battelle Memorial Inst., Columbus, Ohio). Jan. 4, 1968. Contract AT(26-1)-171. 131p. Dep. CFSTI.

Plants found in Colombia and Panama are listed under their scientific names, colloquial names, and uses. The list includes approximately 8,000 plants collected along two routes under consideration for a new interocean canal, the so-called Sasardi-Morti route in Panama (Route 17), and the Atrato-Truando route in Colombia (Route 25). (C.H.)

13596 (BMI-171-15) EFFECTS UPON PLANTS DUE TO NONRADIOACTIVE FALLOUT. Bioenvironmental and Radiologican-Safety Feasibility Studies, Atlantic-Pacific Interoceanic Canal. Clymer, A. Ben (Battelle Memorial Inst., Columbus, Ohio). Oct. 2, 1968. Contract AT(26-1)-171. 30p. Dep. CFSTI.

Data are presented on the content of organic matter, pH, and content of K, Mg, Ca, P, and N in soil samples collected along proposed routes for an interocean canal in Colombia and Panama. The possible effects of radioisotopes from fallout from nuclear explosions on the content of nutrients in the soil and on the development of rice, bananas, coconut palms, sugarcane, and citrus fruits were evaluated. (C.H.)

13597 (BMI-171-109) COMMERCIAL FISHERIES RELATED TO AMCHITKA ISLAND. Amchitka Bioenvironmental Program. Abrams, J. P.; Kemp, H. T.; Kirkwood, J. B. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1968. Contract AT(26-1)-171. 70p. Dep. CFSTI.

A review is presented of the life cycles, migration patterns, catch methods, catch statistics, and value of the commercially harvested marine life forms in the Bering Sea and North Pacific Ocean around Amchitka Island, where AEC-NVOO tentatively proposes to conduct one or more deeply emplaced nuclear tests. The annual value of the marine harvest in the area of interest is estimated to be in excess of $200 million. The most important types of fish are the five species of salmon that migrate through the area. Large numbers of salmon are taken on the high seas by the Japanese in the area around Amchitka, while many are taken in both Asian and American inshore fisheries soon after migration past Amchitka. High-seas salmon fishing activity is greatest from May through August, and the American inshore commercial salmon fisheries operate during the period from May through September. Halibut and other bottom fish, king crab and other shellfish, fur seals, other seals and walrus, five species of whales, and lesser amounts of other assorted fish that are also harvested in the area of interest are present there following normal migratory patterns at various times of the year. In general, harvesting of these species is most intense from May through September, although some harvesting of bottom fish and king crab can occur throughout the year. (auth)

13598 (BMI-171-112) OCEANOGRAPHY AND MARINE ECOLOGY IN THE VICINITY OF AMCHITKA ISLAND. Final Report. Amchitka Bioenvironmental Program. McAlister, W. B.; Mahnken, C.; Clark, R. C. Jr.; Ingraham, W. J.; Larrance, J.; Day, D. (Bureau of Commercial Fisheries, Seattle, Wash. Biological Lab.). Aug. 15, 1968. 146p. Dep. CFSTI. For Battelle Memorial Inst., Columbus, Ohio.

A 6-week oceanographic cruise to the Aleutian Islands near Amchitka Island, was conducted from January 25 to March 15, 1968. Two East-West oceanographic sections along the Aleutian Arc and three North-South sections normal to the Island arc were occupied. A total of 71 STD casts were made to determine the hydrographic features of oceanic and coastal flow. Transport in the Alaskan Stream was 7.5×10^6 m^3/sec; northward transport through Amchitka Pass was 5×10^6 m^3/sec; westward flow south of Amchitka Island was 12×10^6 m^3/sec. Chemical analyses were made for chloride, phosphate, silicate, strontium, magnesium, calcium, nickel, iron, copper, and zinc. Large volume water samples were collected for radionuclide analyses. Nine one-half day primary productivity experiments were made during the survey. Chlorophyll a, dissolved phosphate and silicate were measured to depths of 200 m whenever possible. Productivity (^{14}C) was measured at 0, 10, 15, 20, and 30 m. Chlorophyll a ranged from 0.00 to 0.44 mg/m^3. Mean chlorophyll a integrated for the water column was 6.6 mg/m^2. No significant difference in values was observed between inshore and offshore stations. A subsurface maximum occurred within the surface mixed layer to a lower limit of 100 m. No consistent pattern of nutrient change with depth was found. Lowest phosphate and silicate (0.88 and 30.00 mg-at/m^3 respectively) were well above limiting amounts for phytoplankton productivity. Mean productivity (^{14}C) for all stations was 38 mg C/m^2/day; offshore stations averaged 47 mg C/m^2/day; and inshore stations averaged 26 mg Carbon/m^2/day. Zooplankton was sampled with a standard POG net at 38 stations in the immediate vicinity of Amchitka Island. Two replicate vertical tows 5 to 10 min apart were made at each station. Copepods were the dominant zooplankton constituent by number contributing 85 percent to the total catch. Biomass ranged from 9.6 to 107 ml/1,000 m^3. (auth)

13599 (CU-3957-1) THE EFFECT OF CHEMICAL MODIFICATION OF DNA ON ITS MACROMOLECULAR STRUCTURE. Progress Report, May 1, 1968-January 31, 1969. Krasna, Alvin I. (Columbia Univ., New York). 12p. Dep. CFSTI.

Studies were continued on the properties of DNA by the technique of low-angle light scattering. Efforts were directed to three main areas: a reproducible method for clarification of native DNA solutions by filtration, procedures for clarification of denatured DNA, and a study of the denaturation of DNA by low-angle light scattering. The effects of methylation of DNA on its macromolecular and biological properties were studied. (M.C.G.)

13600 (IN-1262) BIBLIOGRAPHY OF LASER PUBLICATIONS OF INTEREST TO EMISSION SPECTROSCOPISTS. [PART] II. Baldwin, Jon M. (ed.) (Idaho Nuclear Corp., Idaho Falls). Dec. 1968. Contract AT(10-1)-1230. 14p. Dep. CFSTI.

One hundred and fifty-nine references are grouped, alphabetically by author, under the following categories: laser beam interactions with gases, laser beam interactions with condensed phases, and laser applications to spectrographic analysis. (M.C.G.)

13601 (LA-4038) THEORETICAL EXTENSION OF THE REDUCED-CELL CONCEPT IN CRYSTALLOGRAPHY. Roof, R. B. Jr. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 67p. Dep. CFSTI.

Special and degenerate representations for reduced cells were derived from the 41 Niggli matrices for general reduced cells. They are combined with the representations for the general cells to form an expanded classification scheme based on specific relationships between the individual elements of the matrix representation. This forms a foundation for a computer program for indexing unknown x-ray powder patterns. (M.C.G.)

13602 (LPTHE-TH-68/25) QUANTUM MECHANICAL EQUATION OF STATE OF A HARD-SPHERE GAS AT HIGH TEMPERATURE. Jancovici, B. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Aug. 1968. 9p. Dep.

The quantum-mechanical free energy F of a hard-sphere gas at high temperature is a series in powers of the thermal wave-length $\lambda = (2\pi \hbar^2/m\,kT)^{1/2}$; the coefficients of this series can be expressed in terms of the classical correlation functions. The result to first order and the corresponding expression for the pressure is described. The principle of a systematic derivation of higher order terms in λ is given. (auth)

13603 (LPTHE-TH-231) AN EXTENSION OF THE ORNSTEIN-ZERNIKE THEORY OF THE CRITICAL REGION. Stell, G. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Dec. 1967. 8p. Dep.

A new relationship is derived between the shape of the critical isotherm and the range of the two-particle correlation function. (auth)

13604 (NP-17754) DANISH ATOMIC ENERGY COMMISSION, 1967-68. Twelfth Annual Report. (Atomenergikommissionen, Copenhagen (Denmark)). Nov. 1968. 60p. Dep.

Research progress is briefly reported under the following topics: Reactor technology—reactor project DK 400, prestressed concrete pressure vessels, reactor components, fuel element technology, in-pile experiments, safety analysis; reactor physics—theoretical and experimental hydrodynamics, computers; metallurgy—fuel elements, pressure vessel steel; electronics—automation studies, instrumentation and control, simulation studies, nuclear measuring techniques; physics—neutron physics, nuclear physics, stopping power and radiation damage, plasma physics, meteorology; chemistry—lujavrite and eudialyte, applied radiation chemistry, waste disposal, isotope effects, solvent extraction, energy conversion, hot atom chemistry, radiation chemistry, electron spin resonance, etc.; agricultural research—plant breeding, plant diseases, biochemistry, uptake of fission products, selenium, irradiation sprout inhibition; radiation technology—radiosterilization and pasteurization, irradiation dosimetry; isotope production and activation analysis; health and safety—fallout studies, Thute air crash, personnel, plant and environmental control, and radiation detector development; education and training; and library and information services. (Denmark)

13605 (ORNL-4314) JOURNAL CONTROL SYSTEM AT OAK RIDGE NATIONAL LABORATORY. Opstrup, Shirley B.; Klein, Ann S. (Oak Ridge National Lab., Tenn.). Jan. 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

The ORNL Central Research Library has transferred its handling of journals to a computer. A series of programs have been written to provide management information in the form of cost, subscriber, and title statistics and to simplify and accelerate the handling of journals in the library. The arrangement of the sections in this report is in the order that the programs were implemented to the total automated journal system. Section 1 describes the maintenance of the three basic journal information files (title, subscriber, and vendor), the control of ordering and statistics, and the automation of renewal of journals. Section 2 discusses the checking in, binding, and claiming of journals. Section 3 is concerned with programs which provide a union list of all journals in the Knoxville-Oak Ridge area. The Appendix contains data flow charts of programs in the system. (auth)

13606 (ORNL-tr-2025) ECONOMIC STUDY OF INHIBITION OF POTATO SPROUTING BY GAMMA IRRADIATION. Papadopulos, Celso C. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from report CNEA-231. 31p. Dep. CFSTI.

The possibility of using gamma irradiation of potatoes as a commercial process to inhibit sprouting is evaluated. The objective of the process is to put at the public's disposal a product of good quality and low cost, when cultivation and marketing conditions are such that the supply is less than the demand and the price of potatoes increases significantly at certain times of the year. The variables that characterize the production and marketing of potatoes in Argentina, information on experiments carried out in Argentina and other countries on potato sprout inhibition by irradiation, and the economic advantages of the process are discussed. (J.C.W.)

13607 (UCRL-18631) KINETICS OF EVAPORATION AND CONDENSATION REACTIONS. Searcy, Alan W. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1968. Contract W-7405-eng-48. 43p. (CONF-680940-1). Dep. CFSTI.

From 1st International Conference on Materials Science, Como, Italy.

Evaporation reactions were analyzed as two-step processes in which either a surface or desorption step may be rate limiting. Experimental kinetic data were used to determine whether the rate-limiting step could be identified. Generalizations about evaporation coefficients for various classes of solids are presented. The relationship of condensation coefficients to evaporation coefficients is discussed. (M.C.G.)

13608 (UCRL-50513) AN EVALUATION OF THE NATURAL FREQUENCIES OF COMBINED SIMPLE SYSTEMS. Hillyer, D. F.; Hamilton, J. F. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 5, 1968. Contract W-7405-eng-48. 27p. Dep. CFSTI.

The basic steps which can be taken to determine analytically the frequency response characteristics of simple spring-mass systems in a vibration environment are outlined. An application of modeling is presented in the form of dynamic coupling of flexible vibration fixtures and test items during laboratory vibration tests. Methods of correcting experimental data where dynamic coupling has occurred are shown to provide correlation with the analytical model. The basic analytical tools to solve individual problems in structural dynamics are given; however, expansion of these methods to more complex modeling is encouraged only where digital computer analyses can be made. (auth)

13609 (UCRL-50534) A PROGRAM EDITING AND ASSEMBLY SYSTEM FOR THE PDP-8 COMPUTER USING IBM-COMPATIBLE MAGNETIC TAPE. Uber, Donald C. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 18, 1968. Contract W-7405-eng-48. 27p. Dep. CFSTI.

Software is given with which PDP-8 assembly language programs can be edited and assembled from IBM-compatible magnetic tape. The Digital Equipment Corporation PDP-8 Symbolic Editor and Macro-8 Assembler are used, with modifications for magnetic tape I/O. These modified programs require 8192 12-bit words of core memory, and have been written for the DEC 57A Magnetic Tape Control and a single tape transport. Simple modifications of the programs also permit use with different magnetic tape systems. (auth)

13610 (Y-1655) FRINGES-TO-INCHES CONVERTER FOR INTERFEROMETRIC MEASUREMENT AND CONTROL. Lay C. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 23, 1969. Contract W-7405-eng-26. 15p. Dep. CFSTI.

A high-speed fringes-to-inches converter, which utilizes integrated circuits, has been developed at the Oak Ridge Y-12 Plant. Because of its high speed, reliability, and low cost, the converter is economically suitable for inspection and production machines. (auth)

13611 ATOMIC ENERGY LEGISLATION THROUGH NINETIETH CONGRESS, SECOND SESSION. JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, DECEMBER 1968. Washington, D. C., Joint Committee on Atomic Energy, 1969. 375p. GPO $1.50.

13612 INTERNATIONAL AGREEMENTS FOR COOPERATION: 1967-68. HEARINGS BEFORE THE SUBCOMMITTEE ON AGREEMENTS FOR COOPERATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST AND SECOND SESSIONS, MARCH 20, 1967, AND JUNE 25, 1968. Washington, D. C., Joint Committee on Atomic Energy, 1969. 472p. GPO.

13613 SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY. MINUTES OF EVIDENCE, 28th NOV. 1968. SESSION 1968-69. CULHAM LABORATORY. Hill, J. M.; Pease, R. S. London, Her Majesty's Stationery Office, 1968. 13p. 3s. 6d.

Evidence presented before the Committee in connection with the work of the Culham Laboratory of the United Kingdom Atomic Energy Authority, Abingdon, England is reproduced. (UK)